

FEB 0

155479

**ADDENDUM NO. 5
QUALITY ASSURANCE PROJECT PLAN
QUARTERLY GROUNDWATER MONITORING**

FOR THE

**BLACKWELL LANDFILL
DUPAGE COUNTY, ILLINOIS**

Montgomery Watson File No. 1252008

Prepared For:

**DuPage County Forest Preserve District
DuPage County, Illinois**

Prepared By:

**Montgomery Watson
2100 Corporate Drive
Addison, Illinois 60101**

February 1998



MONTGOMERY WATSON

**ADDENDUM NO. 5
QUALITY ASSURANCE PROJECT PLAN
QUARTERLY GROUNDWATER MONITORING**

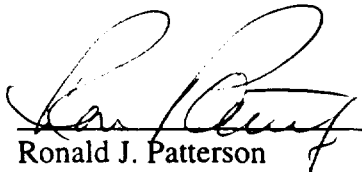
FOR THE

**BLACKWELL LANDFILL
DUPAGE COUNTY, ILLINOIS**

Prepared For:

**DuPage County Forest Preserve District
DuPage County, Illinois**


Prepared by:



Ronald J. Patterson
Principal Hydrogeologist

February 4, 1998
Date

Approved by:



Walter G. Buettner
Supervising Engineering, P.E.

Feb 4/98
Date

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1.0 INTRODUCTION.....	1
2.0 QUALITY ASSURANCE PROJECT PLAN.....	1
3.0 ALTERNATIVE ANALYTICAL METHODS.....	2
4.0 TABLE FOR ADDENDUM NO. 4.....	2
5.0 FIELD PARAMETER MEASUREMENTS.....	3
6.0 PROJECT ORGANIZATION AND RESPONSIBILITY.....	3

LIST OF FIGURES

Figure 1 Organization Chart: Blackwell Landfill Response Action

LIST OF ATTACHMENTS

Attachment A First Environmental Laboratory SOP for Polynuclear Aromatic Hydrocarbons (PNAs)
Attachment B Prairie Analytical Systems, Inc. State of Illinois Certificate and SOP
Attachment C Practical Quantitation Limits for Sediment and Soil Analytes
Attachment D Operating Manual for Hydrolab DataSonde Multiprobe Logger and Scout 2 Display Unit

1.0 INTRODUCTION

A Quality Assurance Project Plan (QAPP) was previously approved as part of the Pre-Design Investigation Work Plan (Montgomery Watson, August 1996) for the Blackwell Landfill. This approved QAPP presented the organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) procedures for planned sampling and analytical activities. The QAPP also described specific protocols for sampling, sample handling and storage, chain of custody, and laboratory and field analyses.

The following four addenda to the QAPP have been approved since August 1996:

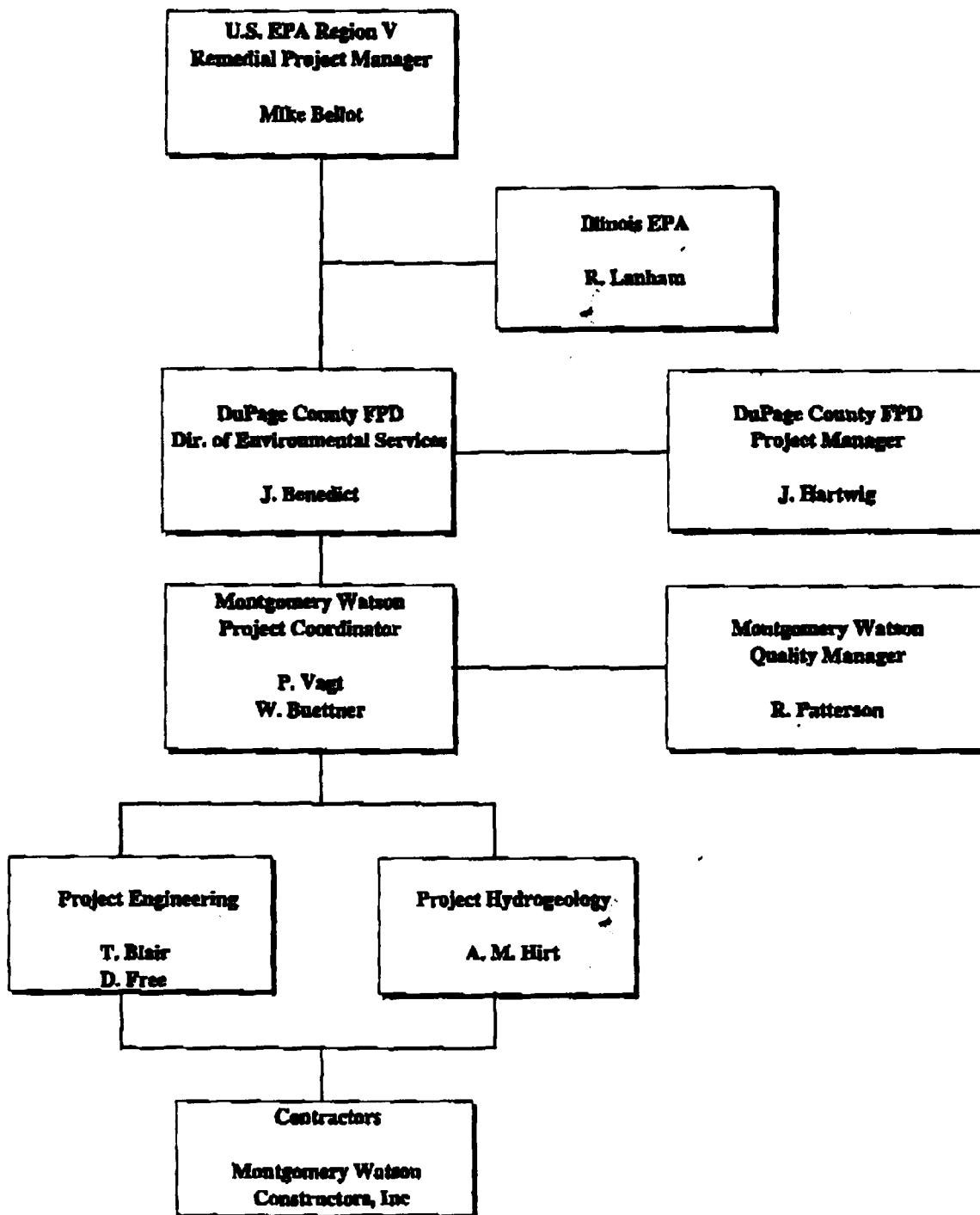
- Addendum No. 1 was prepared as part of the Expedited Final Design Report for the Leachate Collection System (LCS) (Montgomery Watson, May 1997), and provided additional details for sampling and analysis activities associated with the proposed LCS construction.
- Addendum No. 2 described additional quality assurance and quality control activities associated with construction of Cap Repairs.
- Addendum No. 3 provided an updated list of groundwater monitoring wells to be included in the quarterly groundwater monitoring program.
- Addendum No. 4 was prepared to supplement the August 1996 QAPP and an August 1990 Field Sampling Plan, which addressed sediment sampling. This addendum included updated tables that listed requirements for the analysis of soil samples collected during the North Stormwater Pipe Soil Investigation and water samples collected during surface water sampling of Sand Pond.

This Addendum No. 5 has been prepared primarily to address a December 24, 1997 request from U.S. EPA to adopt alternative analytical methods for some compounds on the groundwater analyte list. The compounds were those for which the analytical method practical quantitation limit (PQL) exceeded the promulgated maximum contaminant level (MCL). In addition, this addendum includes a table that was inadvertently omitted from Addendum No. 4, describes changes in the instrumentation for measurement of field parameters, and presents an updated organization chart for the Blackwell Landfill Response Action.

2.0 QUALITY ASSURANCE PROJECT PLAN

Information presented in the August 1996 QAPP and its subsequent addenda is applicable to the quarterly groundwater monitoring program and surface water sampling activities, except as superseded by this addendum.

FIGURE 1
ORGANIZATION CHART
BLACKWELL LANDFILL RESPONSE ACTION



3.0 ALTERNATIVE ANALYTICAL METHODS

The groundwater analytes for which the PQL, as listed in the August 1996 QAPP, exceeds the MCL include vinyl chloride, bis(2-ethylhexyl)phthalate chrysene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene, dibenzo(a,h)anthracene, pentachlorophenol and hexachlorobenzene. Similar PQL exceedances are also associated with these analytes for surface water. The PQLs in the QAPP are those specified for the analytical method, not those that may be effectively achieved by the laboratory. First Environmental Laboratory has indicated that, based on method detection limit (MDL) studies, reporting limits for vinyl chloride and bis(2-ethylhexyl)phthalate that meet the MCLs of 2 and 6 µg/L, respectively, can be achieved with the current analytical methods. Consequently, no changes in analytical methods are required for these two compounds. However, for the other compounds, alternative analytical methods are necessary to achieve PQLs that are equivalent to MCLs. The following table indicates alternative analytical methods for these compounds as well as the associated lower PQLs that may be achieved by these methods in the absence of matrix interference.

Compound	PQL (ug/L)	Alternative Analytical Method
Chrysene	0.2	SW-846 method 8270 (modified)
Benzo(a)pyrene	0.2	SW-846 method 8270 (modified)
Indeno(1,2,3-cd)pyrene	0.2 ^{0.4}	SW-846 method 8270 (modified)
Dibenzo(a,h)anthracene	0.3	SW-846 method 8270 (modified)
Hexachlorobenzene	1	EPA 525
Pentachlorophenol	1	EPA 525

A standard operating procedure (SOP) prepared by First Environmental Laboratory for the modified method SW-846 8270 that will be used for chrysene, benzo(a)pyrene, indeno(1,2,3-cd)pyrene and dibenzo(a,h)anthracene is provided in Attachment A. Analyses for pentachlorophenol and hexachlorobenzene will be conducted by Prairie Analytical Systems, Inc., Springfield, Illinois, which is certified by the State of Illinois. An SOP for EPA method 525 and documentation of the Prairie Analytical Systems, Inc. state certification are provided in Attachment B.

4.0 TABLE FOR ADDENDUM NO. 4

U. S. EPA noted in the December 24, 1997 letter that quantitation limits for surface water, sediment and soil analyses were not included with Addendum No. 4. Tables listing PQLs for these media were inadvertently omitted. PQLs for surface water are the same as those for groundwater (Table 3.1 in the August 1996 QAPP) except as modified for the alternative analytical methods described above. A table listing sediment and soil analytes and associated PQLs is provided in Attachment C.

5.0 FIELD PARAMETER MEASUREMENTS

The August 1996 QAPP provided SOPs for field measurements of pH, specific conductivity, temperature, redox potential and turbidity. These SOPs were based on field instrumentation available at the time of QAPP preparation. Montgomery Watson will use more recent and improved instrumentation to measure these field parameters during future groundwater sampling activities. A Scout 2 display unit coupled with either a Hydrolab H2O Multiprobe or a Hydrolab DataSonde 3 Water Quality Multiprobe Logger is planned for use in the field. This instrumentation measures pH, temperature, specific conductivity, redox potential, dissolved oxygen and turbidity simultaneously. Since the measurements are obtained in line, sample disturbance and contact with air are minimized and the results should be more representative of in-situ groundwater conditions.

Montgomery Watson will follow the operating and routine preventative maintenance procedures recommended by the manufacturer of these instruments. The Hydrolab operating manuals for the DataSonde and Scout 2 are provided in Attachment D.

6.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Since the QAPP was approved, there have been changes in some key project personnel assignments. An updated organization chart listing key project personnel for the Blackwell Landfill Response Action is provided as Figure 1.

JMK\jmk\RJP\WGB
\\chil_server\jobs\1252\008\00805d59.doc
1252008.051201

A



First Environmental Laboratories

Standard Operating Procedure

Title: Semi-Volatile Organics Analysis; Method 8270C
Polynuclear Aromatic Hydrocarbons (PNAs)

Regulatory References: SW-846; 8270C

Regulatory Limits: Varies

Preservation Requirements: Cool, 4°C

Container: One quart amber or 16 oz wide mouth with Teflon lined closure.

Single Analysis Sample Volume: 1000mL or ~30g.

Holding Time: 7 Days from sample collection (aqueous).
14 Days from sample collection (non-aqueous).

(Range) Reporting Limit: 0.20 to 20 ug/L (ground water samples)
8 to 1650 ug/kg (soil/sediment samples).

Sample reporting limits are highly matrix dependent and will be proportionally higher for sample extracts that require dilution to avoid saturation of the detector.

Summary of Method:

Method 8270C is used to quantitate most neutral compounds (such as PNAs) that are soluble in methylene chloride and capable of being eluted without derivatization as sharp peaks from a gas chromatographic fused-silica capillary column coated with a slightly polar silicone. The GC is programmed to separate the components, which are detected with a mass spectrometer. Prior to using this method, the samples should be prepared by using the appropriate sample preparation and clean-up methods.

1. Instrumentation / Apparatus / Glassware

For a comprehensive listing of the instrumentation, apparatus and glassware required for this method see "Test Methods for Evaluating Solid Waste", SW-846, Method 8270C Section 4.0.

The analyst should be familiar with the operation of the Hewlett Packard Enviroquant data acquisition and reduction software before beginning the analysis of samples.

Instrument Conditions:

GC/MS Instrument Conditions (Splitless Injection)

In this technique the electronically controlled injection port pressure is programmed to allow the maximum amount of analyte to be introduced to the analytical column. The sample is introduced to the narrow bore column using the splitless injection technique.

Column	HP-5MS 30meter
Column ID/Thickness	0.25mm ID 1.12um
Interface	Cap Direct Splitless Inj.
GC Type	HP5890 Series II/Plus
Mass Spectrometer	HP5972A
Tune	DFTPP Tune
Scan Range	35-510 amu
Sampling #	3
Threshold	100
Carrier Gas	Helium
Vacuum Comp.	On
Pressure(1)	20psi @ 50 deg C
Time Pressure(1)	1.0 min
Pressure Rate(1)	99 psi/min
Pressure(2)	5.8 psi
Constant Flow Mode	0.84 mL/min
Inj. B Temp	220 C
Detector B Temp	280 C
Initial Temp	50 C
Initial Time	3 minutes
Rate(1)	10.00 deg C/min
Final Temp(1)	200 deg C
Final Time(1)	0 min
Rate(2)	20.0 deg C/min
Final Temp(2)	290 deg C
Final Time(2)	10.0 min
Total GC run time	32.50 min
Purge B	Off (for 1.0 min)

Table 1

2. Standards

PNA Initial Calibration Preparation

Prepare the following mother solution:

PNA Mother Solution

Calibration Mixture	Catalog #	Initial Conc	Volume	Final Conc
SV Calibration Mix #5 (PNAs)	RK31011	2000 ug/mL	1.0mL	400 ug/mL
B/N Surrogate Standard Mix	RK31024	1000	1.0	200 ug/mL
Methylene Chloride (solvent)			3.0	

Table 2

Prepare 10mLs of a 20.0 ug/mL Standard. This is the high point of the 5-point calibration curve.

- Dilute 500uLs of the PNA mother solution to 10.0 mLs with methylene chloride.

The remaining four points of the calibration curve are made by doing a serial dilution on the 20.0 ug/mL standard. Prepare the serial dilutions according to the following table:

Calibration Solution	0.25 ug/mL	0.50 ug/mL	1.0 ug/mL	5.0 ug/mL
5.0 ug/mL PNA Std	12.5 uLs	25 uLs	50 uLs	250 uLs
uLs Methylene Chloride	987.5	975	950	750

Table 3

Prior to analysis add the appropriate amount of PNA ISTD solution to each vial. (25uL of a 400ug/mL solution will yield 10 ug/mL).

3. Safety

See appropriate section in Safety SOP.

4. Analytical Procedures

4.1 Tune the GC/MS system using "Target Tune". Store the tune values in the file named "dftpp.u". Store the hardcopy output in the daily QA/QC file folder.

4.2. Analyze Tuning Compound DFTPP: Prior to the analysis of any standards or samples, a DFTPP must be analyzed and meet quality criteria. This must be done at the start of every 12-hour batch. Inject 1.0 uL of DFTPP tuning solution (25 ng/uL) into the gas chromatograph injection port. When setting up your batch sequence, indicate that this run is "DFTPP" in the sample type field. This will automatically evaluate the DFTPP run and issue a report. In this report, all ions should indicate "PASS". If not, re-tune as in 4.1 above and repeat the DFTPP analysis. The mass spectrum of the DFTPP must meet the following criteria:

Mass	Intensity Required (relative abundance)
51	30 to 60% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	40 to 60% of mass 198
197	<1% of mass 198
198	Base peak, 100% relative abundance
199	5 to 9% of mass 198
275	10 to 30% of mass 198
365	>1% of mass 198
441	Present but less than mass 443
442	> 40% of mass 198
443	17 to 23% of mass 442

Table 7

4.3 Analyze Initial Calibration Standards. Analyze the 5-point calibration mixtures that are detailed in Section 2; Table 4 or 5. Analyze these samples using the conditions and method parameters detailed in Section 1.

4.4 The percent relative deviation (%RSD) should be less than 15% for all compounds. The %RSD for each CCC compound (Table 4 from method 8270B) must be less than 30%. The relative retention times of each compound in each calibration run should agree within 0.06 relative retention time units.

4.5 Analyze Daily Continuing Calibration Standard: Prepare and analyze the 50.0 ppm concentration standard. Analyze this sample using the conditions and method parameters detailed in section 1.

To evaluate the results of this run enter the ENVDA program. Select "File" and load the correct data file. Select "Method" and load the proper method, 8270a.m. Select the option "Concal", then select "Evaluate Data as Continuing Calibration to Printer". This will generate a report that compares this standard analysis to the initial calibration curve. All of the continuing calibration compounds should all be less than 20% (Compounds above 20% will be indicated with a "#" on this report). If any of these are out of control, re-run the standard or prepare a new 5-point calibration. (Check the areas of the peaks with QEDIT to be sure they have been integrated properly) A Continuing Calibration Standard must be analyzed every 12 hours during analysis.

4.6 Analyze Extraction Method Blank: Analyze this sample using the conditions and method parameters detailed in section 1.

Evaluate the Method Blank. No target compounds should be present (with the exception of phthalate compounds which should not be present above 5 times the PQL). Proceed with sample analysis if all indicators are within control limits.

4.7 Analyze each sample. Analyze each standard, blank, MS, MSD, LCS and sample using the conditions and method parameters detailed in section 1. Evaluate each sample chromatogram for the presence/absence of target compound analytes.

4.7.1 Sample Calculations. Calculate the concentration of each identified analyte in the sample as follows:

$$\text{Water Concentration (ug/L)} = (A_x) (I_s) (V_{ex}) / (A_{is}) (RF) (V_o)$$

where:

A_x	=	Area of characteristic ion for compound being measured
I_s	=	Amount of internal standard being injected (ng).
A_{is}	=	Area of characteristic ion for the internal standard
RF	=	Mean relative response factor for compound being measured.
V_o	=	Volume of liquid extracted taking into consideration any dilutions made.
V_{ex}	=	Volume of final extract (mL)

$$\text{Soil Concentration (ug/kg)} = (A_x) (I_s) (V_f) / (A_{is}) (RF) (W_s) (D)$$

where:

A_x	=	Area of characteristic ion for compound being measured
I_s	=	Amount of internal standard being injected (ng).
A_{is}	=	Area of characteristic ion for the internal standard
RF	=	Mean relative response factor for compound being measured.
V_f	=	Volume of final extract (uL)
W_s	=	Weight of sample extracted (g).
D	=	% dry weight of sample/100, or 1 if sample is to be reported on a wet-weight basis.

4.8 Analyze a MS/MSD pair for every 20 sample analyses or according to the frequency dictated by the QAPP for the sample project.. The MS/MSD pair should be evaluated for accuracy (% recovery) and precision (%RPD). The results should be tabulated and included in the daily QC package. The following sub-set compounds should be used. Recovery criteria will be established and updated by determining the standard deviation every 30 samples. The UCL and LCL will be +/- 3 times the standard deviation. Control charts with this data will be maintained and updated on a routine basis.

5. Interferences

The analytical system should be checked to ensure freedom from interferences, under the analysis conditions, by analyzing method blanks. Cross-contamination can occur whenever high-concentration and low-concentration samples are analyzed sequentially. Whenever an unusually concentrated sample is analyzed, it should be followed by the analysis of solvent to check for carry-over contamination. The low-concentration sample that may have followed a high-concentration sample should be re-analyzed to confirm the analytical result. To reduce carry-over, the sample syringe should be rinsed out between sample injections.

6. Quality Control Indicator Assessment

DFTPP and a continuing calibration standard must be run every 12 hours prior to the analysis of samples.

A method blank should be analyzed with every analytical batch. No target compounds should be present (with the exception of phthalate compounds, which should not be present above 5 times the PQL).

An MS/MSD pair should be extracted for every twenty samples.

A Laboratory Control Spike (LCS) may be required if the MS/MSD is outside control limits. An LCS should be extracted for every 20 samples in the event it will need to be evaluated. An LCS is an aliquot of laboratory DI water spiked with the MS/MSD spiking solution.

The internal standard responses and retention times in the analytical batch must be evaluated immediately after or during data acquisition. If the retention time for any internal standard changes by more than 30 seconds from the last calibration check (12 hours), the chromatographic system must be inspected for malfunctions and corrections must be made as required. If the EICP area for any one of the internal standards changes by a factor of two (-50% to +100%) from the last daily calibration check standard, the mass spectrometer must be inspected for malfunctions and corrections must be made as appropriate. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is required.

Surrogate compounds will be added to every standard, blank and sample that is analyzed. The surrogate recoveries must fall within the following specifications. If any one recovery is outside these limits, the sample must be re-analyzed to establish that a sample matrix effect is present.

Surrogate Compound	Low/High Water	Low/High Soil/Sediment
Nitrobenzene-d5	35-114	23-120
2-Fluorobiphenyl	43-116	30-115
Terphenyl-d14	33-141	18-137

7. Notes

Routine Maintenance. The analyst should be familiar with the routine maintenance procedures for both the chromatographic and mass spectrometer systems. Routine maintenance should include, but not be limited to, septum changes, column cutting, mass spectrometer source cleaning, vacuum pump fluid replacement and GC inlet cleaning. The analyst must be aware of system indicators and quality control indicators that warrant attention to these maintenance procedures. The analyst should contact a supervisor if there is any question about these procedures.

For the analysis of PNAs by method 8270, we analyze and evaluate the data for only the target compounds of interest. The initial calibration mixture, continuing calibration mixture and MS/MSD solutions contain only a sub-set of the entire 8270 list. The QA/QC performed on this analysis is used to evaluate only the 16 PNA compounds.

The %RPD and Response Factors for the PNA compounds are evaluated in the initial and continuing calibration standards. These are evaluated to insure that there is no degradation in the standard material or in the chromatographic system. Since the analysis is only interested in the PNA compounds, it is only these compounds that are evaluated.

8. Approvals

Reviewed for Technical Accuracy by: _____

Reviewed for Quality Assurance Compliance by: _____

Implementation Date: _____

End Use Date: _____

B



**STATE OF ILLINOIS
ENVIRONMENTAL PROTECTION AGENCY
AWARDS THIS CERTIFICATE OF APPROVAL**

According to the Illinois Administrative Code, Title 35, Subtitle A, Chapter II, Part 183,
Joint Rules of the Illinois Environmental Protection Agency, the Illinois Department of Public Health and the Illinois Department of Nuclear Safety:
Certification and Operation of Environmental Laboratories, Subparts A and B,
the State of Illinois formally recognizes that the following laboratory is technically competent to perform the analyses listed on this certificate.

**Prairie Analytical Systems, Inc.
205 Main Terminal - Capitol Airport, P.O. Box 8326
Springfield, Illinois 62791-8326**

Scope of certification for chemical analyses in potable water:

EPA Method 524.2, Rev. 4.0: Provisionally for TTHMs and Provisionally for Regulated VOCs including vinyl chloride;

EPA Method 525.2, Rev. 1.0: Alachlor, Aldrin, Atrazine, Benzo[a]pyrene, DDT, Di (2-ethylhexyl) adipate, Di (2-ethylhexyl) phthalate, Dieldrin, Endrin, Heptachlor, Heptachlor epoxide, Hexachlorobenzene, Hexachlorocyclopentadiene, Lindane, Methoxychlor, Simazine;

SM18-2320B: Total Alkalinity; **SM18-3113B:** Provisionally for Lead; **SM18-3500-Ca-D:** Calcium;
and **SM18-4500-H-B:** Provisionally for pH.

Prairie Analytical Systems, Inc. agrees to perform all analyses listed on this certificate according to applicable Part 183 requirements and acknowledges that continued certification is dependent on successful ongoing compliance with the applicable requirements of Part 183. Please contact the Illinois Environmental Protection Agency at 217/782-6455 to verify the laboratory's scope of certification and certification status.

Certification by the State of Illinois is not an endorsement or a guarantee of the validity of the data generated by the laboratory.

CERTIFICATE NUMBER: 100323

DATE OF ISSUE: 01/12/98

ON-SITE EVALUATION: 12/22-24/97

DATE OF EXPIRATION: 01/12/99



DIRECTOR

CERTIFICATION OFFICER

DIVISION MANAGER

METHOD 525.2, Rev. 1.0, March 1994**Standard Operating Procedures***Determination of Organic Compounds in Drinking Water
by Liquid-Solid Extraction and Capillary Column
Gas Chromatography/Mass Spectrometry***Section 1 Scope and Application**

1. This is the standard operating procedure for the general purpose method for determination of organic compounds unfinished drinking water, raw source water, or drinking water in any treatment stage. The method is applicable to a wide range of organic compounds that are efficiently partitioned from the water sample onto a C₁₈ organic phase chemically bonded to a solid silica matrix in a cartridge or a disc, and sufficiently volatile and thermally stable for gas chromatography. Single laboratory accuracy and precision data have been determined at two concentrations with two instrument systems for the following compounds:

<u>Compound</u>	<u>MW</u> ¹	Chemical Abstract Service <u>Registry Number</u>
Acenaphthylene	152	208-96-8
Alachlor	269	15972-60-8
Aldrin	362	309-00-2
Ametryn	227	834-12-8
Anthracene	178	120-12-7
Atraton	211	1610-17-9
Atrazine	215	1912-24-9
Benz(a)anthracene	228	56-55-3
Benzo(b)fluoranthene	252	205-82-3
Benzo(k)fluoranthene	252	207-08-9
Benzo(a)pyrene	252	50-32-8
Benzo(g,h,i)perylene	276	191-24-2
Bromacil	260	314-40-9
Butachlor	311	23184-66-9
Butylate	217	2008-41-5
Butylbenzolphthalate	312	85-68-7
Carboxin ²	235	5234-68-4
Chlordane components		
Alpha-chlordane	406	5103-71-9
Gamma-chlordane	406	5103-74-2
Trans nonachlor	440	39765-80-5
Chlomeb	206	2675-77-6
Chlorobenzilate	324	510-15-6
Chlorproham	213	101-21-3
Chlorothalonil	264	1897-45-6
Chloropyrifos	349	2921-88-22
2-Chlorobiphenyl	188	2051-60-7
Chrysene	228	218-01-9
Cyanazine	240	21725-46-2
Cycloate	215	1134-23-2
Dacthal (DCPA)	330	1861-32-1

EXHIBIT #9

Revision No 2 - December 1997

METHOD 525.2
Prairie Analytical Systems, Inc
Standard Operating Procedures

Chemical Abstract Service

<u>Compound</u>	<u>MW¹</u>	<u>Registry Number</u>
DDD, 4,4'-	318	72-54-8
DDE, 4,4'-	316	72-55-9
DDT, 4,4'-	352	50-29-3
Diazinon ₂	304	333-41-2
Dibenz(a, h)anthracene	278	53-70-3
Di-n-butylphthalate	278	84-74-2
2,3-Dichlorobiphenyl	222	16605-91-7
Dichlorvos	220	62-73-7
Dieldrin	378	60-57-1
Diethylphthalate	222	84-66-2
Di (2-ethylhexyl)adipate	370	103-23-1
Di (2-ethylhexyl)phthalate	390	117-81-7
Dimethylphthalate	194	131-11-3
2,4-Dinitrotoluene	182	121-14-2
2,6-Dinitrotoluene	182	606-20-3
Diphenamid	239	957-51-7
Disulfoton ₂	274	298-04-4
Disulfoton sulfoxide ₂	290	2497-07-6
Disulfoton sulfone	306	2497-06-5
Endosulfan I	404	959-98-8
Endosulfan II	404	33213-65-9
Endosulfan sulfate	420	1031-07-8
Endrin	378	72-20-8
Endrin aldehyde	378	7421-93-4
EPTC	189	759-94-4
Ethoprop	242	13194-48-4
Etridiazole	246	2593-15-9
Fenamiphos ₂	303	2224-92-6
Fenarimol	330	60168-88-9
Fluorene	166	86-73-7
Fluridone	328	59756-60-4
Heptachlor	370	76-44-8
Heptachlor epoxide	386	1024-57-3
2,2',3,3',4,4',6-Heptachlorobiphenyl	392	52663-71-5
Hexachlorobenzene	282	118-74-1
2,2',4,4',5,6'-Hexachlorobiphenyl	358	60145-22-4
Hexachlorocyclohexane, alpha	288	319-84-6
Hexachlorocyclohexane, beta	288	319-85-7
Hexachlorocyclohexane, delta	288	319-86-8
Hexachlorocyclopentadiene	270	77-47-4
Hexazinone	252	51235-04-2
Indeno(1,2,3,c,d)pyrene	276	193-39-5
Isophorone	138	78-59-1
Lindane	288	58-89-9
Merphos ₂	298	150-50-5
Methoxychlor	344	72-43-5
Methyl paraoxon	247	950-35-6
Metolachlor	283	51218-45-2
Metribuzin	214	21087-64-9
MGK 264	275	113-48-4
Molinate	187	2212-67-1
Norflurazon	303	27314-13-2
2,2',3,3',4,5',6,6'-Octachlorobiphenyl	426	40186-71-8

<u>Compound</u>	<u>MW¹</u>	<u>Chemical Abstract Service Registry Number</u>
Pebulate	203	1114-71-2
2,2',3,3',4,6-Pentachlorobiphenyl	324	60233-25-2
Pentachlorophenol	264	87-86-5
Phenanthrene	178	85-01-8
Permethrin, cis-	390	54774-45-7
Permethrin, trans	390	51877-74-8
Prometon	225	1610-18-0
Prometryn	241	7287-19-6
Pronamide	255	23950-58-5
Propachlor	211	1918-16-7
Propazine	229	139-40-2
Pyrene	202	129-00-0
Simazine	201	122-34-9
Simetryn	213	1014-70-6
Stirofos	364	22248-79-9
Tebuthiuron	228	34014-18-1
Terbacil	216	5902-51-2
Terbufos ₂	288	13071-79-9
Terbutryn	241	886-50-0
2,2',4,4'-Tetrachlorobiphenyl	290	2437-79-8
Toxaphene		8001-35-2
Triademefon	293	43121-43-3
2,4,5-Trichlorobiphenyl	256	15862-07-4
Tricyclazole	189	41814-78-2
Trifluralin	335	1582-09-8
Vernolate	203	1929-77-7
Aroclor 1016		12674-11-2
Aroclor 1221 ³		11104-28-2
Aroclor 1232 ³		11141-16-5
Aroclor 1242 ³		53469-21-9
Aroclor 1248 ³		12672-29-6
Aroclor 1254		11097-69-1
Aroclor 1260		11096-82-5

1. Monoisotopic molecular weight calculated from the atomic masses of the isotopes with the smallest masses.
2. Only qualitative identification of this analyte is possible because of its instability in aqueous matrices. Merphos, carboxin, disulfoton, and disulfoton sulfoxide showed instability within 1 hour of fortification. Diazinon, fenamiphos, and terbufos showed significant losses within 7 days under the sample storage conditions specified in Method 525.2.
3. The method was validated using Aroclors 1016, 1254, 1260 which were selected to represent these Aroclors. The extraction conditions and determinative techniques should produce accuracy and precision data comparable to those for the Aroclors tested.

2. Method detection limit (MDL) is defined as the statistically calculated minimum amount that can be measured with 99% confidence that the reported value is greater than zero. The MDL compound dependent and is particularly dependent on the extraction efficiency and the sample matrix. MDL's for all method analytes are listed in Tables 525-2.

Section 2. Summary of method.

1. Organic compound analytes, internal standards and surrogates are extracted from a water sample by passing 1L of sample water through a cartridge or disk containing a solid matrix with a chemically bonded C_{18} organic phase (liquid-solid extraction, LSE). The organic compounds are eluted from the LSE disk with small quantities of ethyl acetate followed by methylene chloride, and this extract is concentrated further by evaporation of some of the solvent. The sample components are separated, identified, and measured by injecting an aliquot of the concentrated extract into a high resolution fused silica capillary column of a GC/MS system. Compounds eluting from the GC column are identified by comparing their measured mass spectra and retention times to reference spectra and retention times in a data base. Reference spectra and retention times for analytes are obtained by the measurement of the calibration standards under the same conditions used for the samples. The concentration of each identified component is measured by relating the MS response of the quantitation ion produced by that compound to the MS response of the quantitation ion produced by a compound used as an internal standard. Surrogate analytes, whose concentration are known in every sample, are measured with the same internal standard calibration procedure.

Section 3. Definitions

Refer to Section 7.0 of the QAQC Manual, Revision 1.

Section 4. Interferences

Refer to "Determination of Organic Compounds in Drinking Water by Liquid-Solid Extraction and Capillary Column Gas Chromatography/Mass Spectrometry", Rev. 1., USEPA, March 1994 July 1991, Method 525.2.

Section 5. Safety

1. Each chemical shall be treated as a potential health hazard and exposure shall be kept to a minimum. Refer to MSDS sheets and Safety Officer regarding the toxicity or carcinogenicity of chemicals used in this method.

Section 6. Equipment and supplies

1. All glassware must be meticulously cleaned.
2. 1L amber containers fitted with Teflon-lined screw caps for sampling.
3. Volumetric flasks, various sizes.
4. Laboratory or aspirator vacuum system to maintain a minimum vacuum of approx. 66cm of mercury used with disks.

- 5 Micro syringes, various sizes.
6. Vials - various sized amber with Teflon-lined screw caps.
7. Drying column capable of holding 5 to 7 grams of anhydrous sulfate.
8. Analytical balance capable of weighing 0.0001 gram accurately.
9. Fused silica capillary GC column.
10. Gas chromatograph/mass spectrometer/data system (GC/MS/DS) - See QAQC for instrument specifications.
11. Standard filter apparatus, ALL GLASS OR TEFLON LINED, if no manifold is used.
12. Manifold system designed for disk meeting quality control requirements in Section 9 of the Method 525.2.

Section 7. Reagents and standards

- 1 Helium carrier gas, as contaminate free as possible.
2. Liquid-solid extraction (LSE) disks. - disks contain octadecyl bonded silica uniformly enmeshed in the inert material, 47mm in diameter and 0.5 mm in thickness. See Section 9 of the method 525.2 for specifications for the discs.
3. Solvents
 - A. Methylene chloride, ethyl acetate, acetone, toluene and methanol. High purity pesticide quality or equivalent.
 - B. Reagent water.
4. Hydrochloric acid (Hcl), 6N.
5. Sodium sulfate, anhydrous.
6. Standard stock solutions - purchased as certified solutions from Ultra-Scientific or Aldrich Chemical.
7. Primary dilution standard solution. The stock standard solutions are used to prepare a primary dilution standard solution that contains multiple analytes and are purchased from commercial suppliers.
8. Fortification solution of internal standards and surrogates. Prepare an internal

standard solution of acenaphthene-D₁₀, phenanthrene-D₁₀, and chrysene-D₁₂, in methanol, ethyl acetate, or acetone at a concentration of 500 ug/ml of each. This solution is used in the preparation of the calibration solutions. Dilute a portion of this solution by 10 to a concentration of 50ug/ml of each. This solution is used in the preparation of the calibrations standards. Dilute a portion of this solution by 10 to a concentration of 50ug/ml and use this solution to fortify the actual water samples. Similarly, prepare a surrogate compound solution. Surrogate compounds used in developing this method are 1,2-dimethyl-2-nitrobenzene, perylene-D₁₂, and triphenylphosphate.

9. GC/MS check solution. Prepare a solution of methylene chloride of the following compounds at 5ng/ul of each: DFTPP and endrin, and 4,4'-DDT. Store in amber vial.

10. Calibration solutions (CAL1 thru CAL6). Prepare a series of six concentration calibration solutions in ethyl acetate which contain the analytes of interest (except pentachlorophenol, toxaphene and the Aroclor compounds) at suggested concentrations of 10, 5, 2, 1, 0.5, and 0.1 ng/ul, with a constant concentration of 5ng/ul of each internal standard and surrogate in each CAL solution. All calibration solutions should contain at least 80% ethyl acetate to avoid GC problems. IF ALL METHOD ANALYTES ARE TO BE DETERMINED, TWO OR THREE SETS OF CALIBRATION STANDARDS WILL BE REQUIRED. Pentachlorophenol is included in this solution at a concentration four times the other analytes. Toxaphene CAL solutions should be prepared as separate solutions at concentrations of 250, 200, 100, 50, 25 and 10 ng/ul. Aroclor CAL solutions should be prepared individually at concentrations of 25, 10, 5, 2.5, 1, and 0.5 ng/ul. Store in amber vials in a cool place.

11. Use sodium sulfite, anhydrous as a reducing agent.

12. Fortification solution for recovery standard. Prepare a terphenyl-D₁₄ at a concentration of 500 ug/ml in methylene chloride or ethyl acetate. An aliquot of this solution should be added to each extract to check on recovery of the internal standards in the extraction process.

Section 8. Sample collection, preservation and storage.

1. Sample collection. Refer to the QAQC for sample collection, containers.

2. Sample dechlorination and preservation. Preservation of samples are provided in the QAQC. Residual chlorine should be reduced at the sampling site by addition of 40-50mg of sodium sulfite to each water sample. Dechlorination of a sample shall be completed prior to adding acid to lower pH of the sample. Sample pH is adjusted to <2 with 6N hydrochloric acid at the sampling site to retard the microbiological degradation of some analytes in water. Sodium sulfite and HCl shall not be added to sample containers prior to shipping to sampling site.

3. Holding times are specified in the QAQC. All but six compounds are stable for a period of 14 days. Therefore all samples will be extracted within the 14 days and

analyzed within 30 days of sample collection. Extraction of the samples must be done immediately following collection if the following analytes are to be determined: carboxin, diazinon, disulfoton, disulfoton sulfoxide, fenamiphos and terbufos.

4. Field reagent blanks - Duplicate field reagent blanks must be handled with each sample set. At the laboratory, fill field blank sample bottles with reagent water, seal and ship to the sampling site along with empty bottles and back to the lab with the filled sample bottles.

Section 9. Quality control

1. Quality control (QC) requirements are the initial demonstration of laboratory capability followed by regular analyses of laboratory reagent blanks, laboratory fortified blanks and laboratory fortified matrix samples. Maintain all records.

2. Initial demonstration of low disk system background. - Before any samples are analyzed, demonstrate that a laboratory reagent blank (LRB) is reasonably free of contamination that could prevent the determination of an analyte of interest. At the same time demonstrate that the preparation of the disks is acceptable.

- A. A source of potential contamination is the liquid-solid extraction (LSE) disk which may contain phthalate material which can be leached from the disk into ethyl acetate or methylene chloride and produce a variable background in the water sample. If the background is sufficient to prevent an accurate and precise measurement, the condition must be corrected before proceeding with the demonstration.

- B. Other sources of background contamination are solvents, reagent and glassware.

- C. Using full aspirator or pump vacuum, approximately 5-20 minutes will be required to pass 1 L of drinking water through the disk.

3. Initial demonstration of laboratory accuracy and precision. - analyze a minimum of four replicates of laboratory fortified blank containing each analytes of interest at a suggested concentration of 5 ug/l.

- A. Prepare each replicate by adding sodium sulfite and HCl according to Section 8.2, then adding an appropriate aliquot of the primary dilution standard solution, or another quality control sample to reagent water. Analyze each replicate according to procedures specified in Section 11.

- B. Calculate the measured concentration of each analyte of each replicate, the mean concentration of each analytes in all replicates, and mean accuracy (as mean percentage of true value) for each analytes, and the precision (as relative standard deviation), RSD of the measurements for each analyte.

C. For each analyte and surrogate, the mean accuracy, expressed as a percentage of the true value, should be 70 -130% and the RSD should be <30%.

D. Analyze seven replicate laboratory fortified blanks which have been fortified with all analytes of interest at approximately 0.5 ug/l. Calculate the MDL of each analyte using the procedure described in Section 13. Perform these analyses over several day period.

E. Develop and maintain a system of control charts to plot the precision and accuracy of analyte and surrogate measurements as a function of time. Provides a significant record of data quality.

4. Monitor the integrated areas of the quantitation ions of the internal standards and surrogates in continuing calibration checks. In LFB or samples, the integrated areas of internal standards and surrogates will not be constant because of the volume of the extract will vary, however, the ratios should be reasonably constant. The addition 10ul of the recovery standard, terphenyl-D₁₂ (500 ug/ml) to the extract is recommended to be used to monitor the recovery of the internal standards. Recovery should be in excess of 70%.

5. With each batch of samples processed as a group within a 12 hour shift, analyze a LRB to determine background determination.

6. With each batch of samples processed as a group within a work shift. Analyze a LFB containing each analyte of interest at a concentration of 2.0 ug/l. If more than 20 samples are in a batch, analyze one LFB with each twenty samples.

7. Determine that the sample matrix does not contain materials that adversely affect method performance by analyzing replicates of LFMS and ascertaining that the precision, accuracy and method detection limits of analytes are in the same range as obtained with the LFB.

8. With each set of samples, a field reagent blank shall be analyzed.

9. At least quarterly, analyze a quality control sample from an external source.

Section 10. Calibration and standardization

1. After initial calibration, a continuing calibration check is required each day or at the beginning of each period in which analyses are performed - not to exceed 12 hours.

A. Calibrate the mass and abundance scales of the MS with calibration compounds and procedures.

B. Inject into the GC/MS a 1 ul aliquot of the 5ng/ul solution of DFTPP, endrin and 4,4'-DDT. Acquire a mass spectrum that includes data for m/z 45-450. Use GC conditions that produce a narrow peak for each compound. Calculate

percent breakdown using peak areas based on total ion current (TIC) as follows:

% 4,4'-DDT breakdown =

$$\frac{\Sigma \text{TIC area of DDT degradation peaks (DDE plus DDD)}}{\Sigma \text{TIC area of total DDT peaks (DDT plus DDE plus DDD)}} \times 100$$

% endrin breakdown =

$$\frac{\Sigma \text{TIC area of endrin degradation peaks (EA plus EK)}}{\Sigma \text{TIC area of total endrin peaks (endrin plus EA plus EK)}} \times 100$$

C. Inject a 1ul aliquot of a medium concentration calibration solution and acquire and store data from m/z 45-450 with a total cycle time of 1.0 sec or less.

1. Multi-ramp temperature program. - Adjust the helium gas flow to about 33cm.sec. Inject at 45°C and hold splitless mode for 1 minute Heat rapidly to 130°C. At 3 min start temperature program: 130-180°C at 12 min; 180-240°C at 7o/min; 240-320°C at 12 min.

D. Performance criteria for medium calibration.

1. GC performance. - Anthracene and phenanthrene should be separated by baseline. Benz(a)anthracene and chrysene should be separate by a valley whose height is less than 25% of the average peak of these two compounds.

2. MS Sensitivity - The GC/MS/DS peak identification software should be able to recognize a GC peak in the appropriate retention time window for each of the compounds in the calibration solution and make correct identification. If fewer than 99% of the compounds are recognized, system requires maintenance. (See QAQC)

E. If all performance criteria is met, inject 1ul aliquot of each of the other CAL solutions using the same GC/MS conditions.

F. Calculate a response factor (RF) for each analyte of interest and surrogate using the internal standard whose retention time is nearest the retention time of the analyte or surrogate. Table 2 of the Method 525.2 contains suggested internal standards for each analytes and surrogate and the quantitation ions for all compounds. The RF is a unitless number, but units used to express quantities of analytes and internal standard must be equivalent.

$$RF = \frac{(A_s)(Q_{is})}{(A_{is})(Q_s)}$$

where:

A_s = Integrated abundance of the quantitation ion of the analyte

A_{is} = Integrated abundance of the quantitation ion of the internal standard

C_{is} = Quantity of the analyte injected in ng or concentration units

C_s = Quantity of internal standard injected in ng or concentration units

1. For each analyte and surrogate, calculate the mean RF from the analyses of the six CAL solutions. Calculate the standard deviation (SD) and the relative standard deviation (RSD from each mean: $RSD = 100 (SD/M)$). If the RSD of any analyte or surrogate mean RF exceeds 30%, either analyze additional aliquots of appropriate CAL solutions to obtain an acceptable RSD of RFs over the entire concentration range, or take action to improve GC/MS performance.
2. As an alternative to calculating mean response factors, use the GC/MS data system software to generate a linear regression calibration curve.
3. Continuing calibration check - Verify the MS tune and initial calibration at the beginning of each 12 hour shift during which analyses are being performed.
 - A. Inject a 1 ul aliquot of the 5 ng/ul solution of DFTPP, endrin, and 4,4'-DDT. Acquire a mass spectrum for DFTPP that includes data for m/z 45-450.
 - B. Inject a 1 ul aliquot of a medium concentration calibration solution and analyze with the same conditions used during the initial calibration.
 - C. Demonstrate acceptable performance for the criteria shown.
 - D. Determine that the absolute areas of the quantitation ions of the internal standards and surrogates have not decreased by more than 30% from the areas measured in the most recent continuing calibration check, or by more than 50% from the areas measured during initial calibration. If these areas have decreased by more than these amounts, adjustments must be made to restore system sensitivity. These adjustments may require cleaning of the MS ion source, or other maintenance as indicated and calibration. Control charts are useful aids in documenting system sensitivity changes.
 - E. Calculate the RF for each analyte and surrogate from the data measured in the continuing calibration check. The RF for each analyte and surrogate must be within 30% of the mean value measured in the intimal calibration. Alternatively,

if a linear regression is used, the calculated amount for each analyte must be $\pm 30\%$ of the true value. If these conditions do not exist, remedial action should be taken which may require recalibration.

1. Because of the large number of compounds on the analyte list, it is possible for a few analytes of interest to be outside the continuing calibration criteria. If analytes that missed the calibration check are detected in samples, they may be quantified using a single point calibration. The single point standards should be prepared at concentrations that produce responses close ($\pm 20\%$) to those of the unknowns. If the same analyte misses the continuing calibration check on three consecutive work shifts, remedial action **MUST** be taken. If more than 10% of the analytes of interest misses the continuing calibration check on a single day, remedial action **MUST** be taken.

Section 11. Procedure

1. Cartridge extract - follow the recommendations of the manufacturer when using automatic sample preparation. - Not used by this facility.
2. Disk extraction
 - A. Use standard 47mm diameter disks.
 1. Insert disk into the filter apparatus, wash with 5ml of a 1:1 mixture of methylene chloride and ethyl acetate by adding solvent to the disk and drawing about one-half of the mixture through the disk. Allow it to soak about one minute and draw the remaining solvent through the disk.
 2. Prewet disk with 5ml methanol by adding MeOH to the disk and allowing it to soak for about one minute. Draw most of the MeOH through the disk. Leave a layer of MeOH on the disk and do not let the disk go dry until the end of the extraction. This is necessary for uniform flow and good recovery.
 3. Rinse with 5ml reagent water, again leaving some of the water on the disk.
 - B. Add 5ml of MeOH per liter of water to sample. Mix well.
 - C. Add 100ul of the internal standard and surrogate compound fortification solution (50ul) to the sample and mix until homogenous. Resulting concentration should be 5ul.
 - D. Add the water sample to the reservoir and apply full vacuum to begin extraction.

- E. Remove the filtration top, but do not disassemble the reservoir and fritted base
- F. Add 5ml of ethyl acetate to the sample bottle and rinse the walls thoroughly. Allow the solvent to settle to the bottom of the container and then transfer to the disk. Draw about half of the volume through the disk, let the remainder soak for about one minute and then draw the remainder through the disk.
- G. Repeat the above step with methylene chloride.
- H. Using a syringe, rinse the filtration reservoir with 3ml portions of 1:1 Ethyl acetate and methylene chloride. Draw the solvent through the disk and into the collector tube. Pour the combined eluates through the drying tube containing 5 to 7 grams of sodium sulfate, anhydrous. Rinse the drying tube with 3ml portions of 1:1 ethyl acetate and methylene chloride. Collect the extract and washing in a collector tube.
- I. While heating extract in water bath, concentrate to about 0.5 to 1 ml under a gentle stream of nitrogen. DO NOT CONCENTRATE TO LESS THAN 0.5 ML.
3. Analyze a 1-2 ul aliquot with the GC/MS system under the same conditions used for the initial calibration and continuing calibration.
4. Use the data system software to examine the ion abundances of components of the chromatogram.
5. Identify analytes.
6. Structural isomers that produce very similar mass spectra can be explicitly identified only if they have sufficiently different GC retention times.

Section 12. Data analysis and calculations

1. Complete chromatographic resolution is not necessary for accurate and precise measurements of analyte concentrations if unique ions with adequate intensities are available for quantitation. See Table 2 of the Method 525.2.

- A. Calculate analyte and surrogate concentrations:

$$C_x \text{ equals } \frac{(A_x)(Q_i)}{(A_i)RFV}$$

where:

C_x = concentration of analyte or surrogate in ug/l in the water sample
 A_x = integrated abundance of the quantitation ion of the internal standard in sample
 A_{is} = integrated abundance of the quantitation ion of the internal standard in sample
 Q_{is} = total quantity (in micrograms) of internal standard added to water sample
 V = original water sample volume in liters
 RF = mean response factor of analyte from the initial calibration

B. Calculation should utilize all available digits of precision, but final reported concentrations shall be rounded to an appropriate number of significant figures.

Section 13. Method performance

1. Single laboratory accuracy and precision data for each analyte listed are shown in Table 525-1. Refer to MDL in Table 525-2.
2. Refer to Method 525.2 Section 13.2 for PAH problem compounds.

Section 14. Pollution prevention

1. Method 525.2 utilizes the new liquid-solid extraction (LSE) technology to remove analytes from water. It requires small volumes of organic solvent and the pure analytes, eliminating the potential hazards to both the analyst and the environment.
2. Refer to the American Chemical Society's publication regarding pollution prevention applicable to laboratories "*Less is Better: Laboratory Chemical Management for Waste Reduction*".

Section 15. Waste management

1. All disposal of samples and analyte of interest waste generated by the laboratory meets all federal, state and local regulations regarding the labeling and disposing of liquid and solid waste. Consult the safety officer for instructions regarding the disposal of waste generated by the operations of the GC/MS

Table 525.2

ACCURACY AND PRECISION DATA FROM EIGHT DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING LIQUID-SOLID C-18 CARTRIDGE EXTRACTION AND THE ION TRAP MASS SPECTROMETER

	True Conc.	Mean Observed Conc.	Relative Standard Deviation	Mean Method Accuracy	MDL
Compound	($\mu\text{g/L}$)	($\mu\text{g/L}$)	(%)	(% of True Conc.)	($\mu\text{g/L}$)
Surrogates					
1,3-dimethyl-2-nitrobenzene	5.0	4.9	8.4	98	
perylene-d12	5.0	4.3	18	86	
triphenylphosphate	5.0	4.8	13	96	
Target Analytes					
acenaphthylene	0.50	0.50	8.8	100	0.13
alachlor	0.50	0.58	4.0	115	0.069
aldrin	0.50	0.42	3.5	85	0.045
ametryn	0.50	0.46	3.3	91	0.045
anthracene	0.50	0.42	3.8	84	0.048
araclor 1016	1.0	1.1	4.4	113	0.15
araclor 1254 ^a	1.0	1.1	17	110	0.59
araclor 1260	1.0	0.96	9.3	96	0.27
atrazin	0.50	0.35	11	70	0.12
atrazine	0.50	0.55	5.0	109	0.081
benz(a)anthracene	0.50	0.43	7.3	85	0.093
benzo(b)fluoranthene	0.50	0.44	16	88	0.21
benzo(k)fluoranthene	0.50	0.34	22	68	0.23
benzo(g,h,i)perylene	0.50	0.38	31	76	0.35
benzo(a)pyrene	0.50	0.36	21	73	0.23
bromacil	0.50	0.45	9.1	90	0.12
butochlor	0.50	0.67	12	133	0.26
butylate	0.50	0.52	5.2	104	0.082
butylbenzylphthalate ^a	5.0	5.7	7.7	114	1.4
carboxin	0.50	0.58	22	117	0.38
chlordane, (alpha-chlordane)	0.50	0.47	12	95	0.17
chlordane, (gamma-chlordane)	0.50	0.50	18	99	0.16
chlordane, (trans-nonachlor)	0.50	0.48	11	96	0.16
chlorob	0.50	0.51	8.1	103	0.13
chlorobenzilate	0.50	0.61	9.7	123	0.17
2-chlorobiphenyl	0.50	0.47	4.8	94	0.068
chlorpropham	0.50	0.55	8.1	109	0.13

Table 525.2

ACCURACY AND PRECISION DATA FROM EIGHT DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING LIQUID-SOLID C-18 CARTRIDGE EXTRACTION AND THE ION TRAP MASS SPECTROMETER (CONTINUED)

Compound	True Conc. ($\mu\text{g/L}$)	Mean Observed Conc. ($\mu\text{g/L}$)	Relative Standard Deviation (%)	Mean Method Accuracy (% of True Conc.)	MDL ($\mu\text{g/L}$)
chlorpyrifos	0.50	0.50	2.4	99	0.035
chlorthalonil	0.50	0.62	5.3	123	0.098
chrysene	0.50	0.50	9.2	99	0.14
cyanazine	0.50	0.49	13	97	0.19
cycloate	0.50	0.52	7.6	103	0.12
DCPA	0.50	0.55	7.2	109	0.12
4,4'-DDD	0.50	0.52	3.6	103	0.055
4,4'-DDE	0.50	0.41	5.8	81	0.070
4,4'-DDT	0.50	0.54	2.4	108	0.039
diazinon	0.50	0.37	2.7	75	0.030
di-benz[a,h]anthracene	0.50	0.37	29	74	0.32
di-n-butylphthalate ^a	5.0	6.2	4.6	124	0.89
2,3-dichlorobiphenyl	0.50	0.45	5.8	90	0.079
dichlorvos	0.50	0.53	8.0	106	0.13
dieldrin	0.50	0.50	10	100	0.15
di(2-ethylhexyl)adipate	0.50	0.59	18	117	0.31
di(2-ethylhexyl)phthalate ^a	5.0	6.5	6.6	130	7.9
diethylphthalate	0.50	0.63	15	126	0.28
dimethylphthalate	0.50	0.51	9.5	102	0.14
2,4-dinitrotoluene	0.50	0.45	18	91	0.26
2,6-dinitrotoluene	0.50	0.40	17	80	0.20
diphenamid	0.50	0.55	6.5	111	0.11
disulfoton	0.50	0.62	9.8	124	0.18
disulfoton sulfone	0.50	0.64	3.5	128	0.068
disulfoton sulfoxide	0.50	0.57	8.6	114	0.15
endosulfan I	0.50	0.60	6.1	121	0.11
endosulfan II	0.50	0.64	3.9	128	0.076
endosulfan sulfate	0.50	0.58	5.4	116	0.093
endrin	0.50	0.62	18	124	0.34
endrin aldehyde	0.50	0.58	8.7	116	0.15
EPIC	0.50	0.53	7.7	105	0.12
ethoprop	0.50	0.62	10	124	0.19

Table 525.2

ACCURACY AND PRECISION DATA FROM EIGHT DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING LIQUID-SOLID C-18 CARTRIDGE EXTRACTION AND THE ION TRAP MASS SPECTROMETER (CONTINUED)

	True Conc.	Mean Observed Conc.	Relative Standard Deviation	Mean Method Accuracy	MDL
Compound	($\mu\text{g/L}$)	($\mu\text{g/L}$)	(%)	(% of True Conc.)	($\mu\text{g/L}$)
acridiazole	0.50	0.61	6.5	122	0.12
fenamiphos	0.50	0.67	12	133	0.24
fenarimol	0.50	0.76	11	148	0.25
fluorene	0.50	0.69	9.0	98	0.13
fluridone	5.0	5.2	2.5	105	0.18
HCH, alpha	0.50	0.55	6.8	109	0.11
HCH, beta	0.50	0.54	5.3	107	0.085
HCH, delta	0.50	0.52	3.1	105	0.049
HCH, gamma (Lindane)	0.50	0.53	5.3	105	0.084
heptachlor	0.50	0.50	4.1	100	0.061
heptachlorepoxyde	0.50	0.54	8.2	108	0.13
2,2',3,3',4,4',6-heptachlorobiphenyl	0.50	0.45	11	90	0.15
hexachlorobenzene	0.50	0.41	6.0	82	0.074
2,2',4,4',5,6'-hexachlorobiphenyl	0.50	0.40	15	80	0.18
hexachlorocyclopentadiene	0.50	0.36	13	68	0.13
hexazinone	0.50	0.80	5.6	159	0.14
indeno(1,2,3-c,d)pyrene	0.50	0.36	28	71	0.30
isophorene	0.50	0.54	7.9	107	0.13
methoxychlor	0.50	0.58	7.7	115	0.13
ethyl parathion	0.50	0.85	3.7	170	0.094
metolachlor	0.50	0.58	4.8	117	0.085
metribuzin	0.50	0.54	14	108	0.22
sevinphos	0.50	0.47	12	95	0.17
HCH 264 - isomer a	0.33	0.38	9.5	113	0.11
HCH 264 - isomer b	0.16	0.18	5.4	105	0.029
collinate	0.50	0.55	5.2	111	0.086
napropamide	0.50	0.63	10	127	0.20
nerflurazon	0.50	0.82	3.8	165	0.093
2,2',3,3',4,5',6,6'-octachlorobiphenyl	0.50	0.40	19	99	0.28
piculate	0.50	0.56	6.1	112	0.10
2,2',3',4,6-pentachlorobiphenyl	0.50	0.43	8.7	86	0.11
pentachlorophenol	2.0	2.4	10	119	0.72

Table 525.2

ACCURACY AND PRECISION DATA FROM EIGHT DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING
 (EQUIDISTANT C-18 CARTRIDGE EXTRACTION AND THE ION PAIR MASS SPECTROMETER (CONTINUED))

Compound	True Conc. ($\mu\text{g/L}$)	Mean Observed Conc. ($\mu\text{g/L}$)	Relative Standard Deviation (%)	Mean Method Accuracy (% of True Conc.)	MDL ($\mu\text{g/L}$)
permethrin, cis	0.25	0.45	3.2	179	0.045
permethrin, trans	0.75	1.1	2.2	153	0.076
phenanthrene	0.50	0.48	4.8	96	0.069
praziquantel	0.50	0.24	27	48	0.20
praziquantel	0.50	0.46	3.0	92	0.041
praziquantel	0.50	0.56	5.3	113	0.08
propachlor	0.50	0.56	6.6	112	0.16
propazine	0.50	0.52	4.3	105	0.064
pyrene	0.50	0.47	11	95	0.16
simazine	0.50	0.48	8.8	96	0.13
simazine	0.50	0.48	2.9	96	0.042
atrazine	0.50	0.80	3.9	160	0.095
terbutyluron	0.50	0.67	7.4	136	0.15
terbacil	0.50	0.59	12	119	0.22
terbufos	0.50	0.46	11	92	0.15
terbutryn	0.50	0.48	2.6	97	0.038
2,2',4,4'-tetrachlorobiphenyl	0.50	0.40	6.6	81	0.077
toxaphene	10	11	4.9	118	1.7
triadimenol	0.50	0.73	6.6	146	0.16
2,4,5-trichlorobiphenyl	0.50	0.44	3.3	88	0.045
trifluralin	0.50	0.43	16	127	0.31
trifluralin	0.50	0.62	13	126	0.24
vernalate	0.50	0.50	9.3	101	0.14

Seven replicates

Seven replicates in fortified tap water.

Table 525.2

— RECOVERY DATA FROM EIGHT DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING LIQUID SOLID C-18 DISC EXTRACTION AND THE ION TRAP MASS SPECTROMETER

Compound	True Conc. (ug/L)	Mean Observed Conc. (ug/L)	Relative Standard Deviation (%)	Mean Method Accuracy (% of True Conc.)	MDL (ug/L)
Surrogates					
1,3-dimethyl-2-nitrobenzene	5.0	4.9	10	98	
perylene-d12	5.0	4.9	4.5	98	
triethylphosphate	5.0	5.9	8.1	117	
Target Analytes					
acenaphthylene	0.50	0.51	4.5	102	0.068
alachlor	0.50	0.54	6.6	108	0.11
aldrin	0.50	0.65	6.3	90	0.085
ametryn	0.50	0.41	23	82	0.29
anthracene	0.50	0.39	15	79	0.18
araclor 1016	1.0	0.94	7.5	94	0.21
araclor 1234	1.0	0.94	7.6	94	0.20
araclor 1260	1.0	1.2	13	125	0.53
atrazin	0.50	0.10	44	21	0.14
atrazine	0.50	0.56	4.6	111	0.076
benz[a]anthracene	0.50	0.44	7.4	88	0.098
benzo[b]fluoranthene	0.50	0.50	9.1	100	0.14
benzo[k]fluoranthene	0.50	0.44	2.2	91	0.031
benzo[g,h,i]perylene	0.50	0.47	7.9	95	0.11
benzo[a]pyrene	0.50	0.44	12	89	0.16
bromacil	0.50	0.49	4.4	99	0.066
butachlor	0.50	0.46	5.1	132	0.10
butylate	0.50	0.50	5.4	100	0.082
butylbenzylphthalate	5.0	5.7	7.7	114	1.4
carbozin	0.50	0.48	38.1	79	0.45
chlordane, (alpha-chlordane)	0.50	0.50	4.3	101	0.065
chlordane, (gamma-chlordane)	0.50	0.51	7.2	102	0.11
chlordane, (trans-nonachlor)	0.50	0.52	6.2	104	0.097
chlornab	0.50	0.54	6.3	108	0.10
chlornabzilate	0.50	0.59	9.7	117	0.17
2-chlorobiphenyl	0.50	0.50	4.7	100	0.070
chlortropath	0.50	0.55	4.7	111	0.079

Table 525.2

ACCURACY AND PRECISION DATA FROM ELUENT DETERMINATIONS OF THE METHOD ANALYTES IN REAGENT WATER USING LIQUID-SOLID C-18 DISK EXTRACTION AND THE ION TRAP MASS SPECTROMETER (CONTINUED)

Compound	True Conc. (ug/L)	Mean Observed Conc. (ug/L)	Relative Standard Deviation (%)	Mean Method Accuracy (% of True Conc.)	MDL (ug/L)
chlorpyrifos	0.50	0.56	11	109	0.18
chlorthalonil	0.50	0.59	6.6	119	0.079
chrysene	0.50	0.68	6.1	96	0.088
cyanazine	0.50	0.52	8.3	105	0.13
cycloate	0.50	0.51	6.1	102	0.063
DCPA	0.50	0.53	3.2	105	0.051
6,6'-DDE	0.50	0.63	16	127	0.31
6,6'-DDE	0.50	0.68	3.7	96	0.054
6,6'-DDE	0.50	0.58	7.2	117	0.13
diazinon	0.50	0.50	6.5	101	0.048
dibenz (a,h) anthracene	0.50	0.67	9.9	94	0.14
di-n-butylphthalate ^a	5.0	5.7	3.3	115	0.59 ^b
2,3-dichlorodiphenyl	0.50	0.50	2.6	100	0.039
dichlorvos	0.50	0.50	8.7	99	0.13
dielzin	0.50	0.53	7.0	106	0.11
di(2-ethylhexyl)adipate ^a	5.0	5.4	7.5	107	1.3
di(2-ethylhexyl)phthalate ^a	5.0	5.7	2.6	116	0.66
diethylphthalate	0.50	0.68	5.0	137	0.18
dimethylphthalate	0.50	0.51	5.0	102	0.077
2,6-dinitroresorcinol	0.50	0.28	6.6	56	0.039
2,4-dinitroresorcinol	0.50	0.30	8.1	59	0.072
diphenylid	0.50	0.56	6.6	112	0.11
diulfecen	0.50	0.70	5.3	139	0.11
diulfecen sulfone	0.50	0.66	5.9	128	0.11
diulfecen sulfonamide	0.50	0.60	3.8	119	0.048
endosulfen I	0.50	0.61	6.9	122	0.089
endosulfen II	0.50	0.66	6.1	131	0.12
endosulfen sulfate	0.50	0.57	9.0	115	0.16
endrin	0.50	0.68	7.9	137	0.16
endrin aldehyde	0.50	0.57	2.8	116	0.048
EPIC	0.50	0.48	5.2	97	0.078
ethoprop	0.50	0.61	7.5	122	0.14

Table 525.2
 COMPARISON OF THE RECOVERY OF THE METHOD ANALYTES IN PERCENT WATER USING
 LIQUID-SOLID 2:18 DISC EXTRACTION AND THE ION TRAP MASS SPECTROMETER (CONTINUED)

Compound	True Conc. ($\mu\text{g/L}$)	Mean Observed Conc. ($\mu\text{g/L}$)	Relative Standard Deviation (%)	Mean Method Accuracy (% of True Conc.)	MDL ($\mu\text{g/L}$)
ectridazole	0.50	0.54	4.2	108	0.067
fenariphos	0.50	0.67	10	133	0.20
fenarimol	0.50	0.59	5.8	118	0.10
fluorene	0.50	0.53	3.4	106	0.054
fluridone	5.0	5.2	2.3	104	0.16
MCH, alpha	0.50	0.55	5.0	110	0.083
MCH, gamma (Lindane)	0.50	0.50	3.2	100	0.067
MCH, beta	0.50	0.54	4.1	109	0.068
MCH, delta	0.50	0.53	3.6	106	0.058
heptachlor	0.50	0.49	4.0	98	0.059
heptachlorepoxyde	0.50	0.50	3.2	100	0.068
2,2',3',4,4',6-heptachlorobiphenyl	0.50	0.46	7.3	92	0.10
hexachlorobenzene	0.50	0.49	3.4	97	0.069
2,2',4,4',5,6'-hexachlorobiphenyl	0.50	0.50	5.3	99	0.079
hexachlorocyclopentadiene	0.50	0.37	9.3	73	0.10
hexazinone	0.50	0.75	4.2	150	0.094
indeno(1,2,3-c,d)pyrene	0.50	0.48	7.3	96	0.10
isophorone	0.50	0.51	4.3	102	0.066
methoxychlor	0.50	0.52	6.7	104	0.18
methyl parathion	0.50	0.75	4.5	151	0.10
metolachlor	0.50	0.57	3.2	114	0.054
metribuzin	0.50	0.53	5.7	107	0.098
sevinphos	0.50	0.56	4.2	112	0.10
MCK 264 - isomer a	0.33	0.38	6.7	113	0.076
MCK 264 - isomer b	0.16	0.18	5.3	110	0.029
salinate	0.50	0.53	3.8	105	0.060
napropamide	0.50	0.58	7.9	116	0.14
nerflurexon	0.50	0.71	4.3	142	0.091
2,2',3,3',4,5',6,6'-octachlorobiphenyl	0.50	0.47	5.3	96	0.076
pebulate	0.50	0.56	7.1	112	0.11
2,2',3',4,6-pentachlorobiphenyl	0.50	0.49	4.0	97	0.059
pentachlorophenol	2.0	2.2	15	111	1.0

Table 525.2
LIQUID-SOLID C-18 DISK EXTRACTION AND THE ION TRAP MASS SPECTROMETER (CONTINUED)

Compound	True Conc. ($\mu\text{g/L}$)	Mean Observed Conc. ($\mu\text{g/L}$)	Relative Standard Deviation (%)	Mean Method Accuracy (% of True Conc.)	MDL ($\mu\text{g/L}$)
permethrin, cis	0.25	0.37	3.1	49	0.035
permethrin, trans	0.75	0.84	1.4	112	0.039
phenanthrene	0.50	0.49	6.3	97	0.092
prometon	0.50	0.16	63	32	0.30
prometryn	0.50	0.46	23	91	0.32
pronamide	0.50	0.56	3.9	111	0.064
propachlor	0.50	0.58	5.7	115	0.098
propazine	0.50	0.53	4.7	106	0.074
pyrene	0.50	0.52	5.2	106	0.080
simezime	0.50	0.54	2.8	107	0.045
simezryn	0.50	0.36	20	71	0.22
stirofos	0.50	0.72	3.7	144	0.080
tebuthiuron	0.50	0.67	7.9	133	0.16
terbacil	0.50	0.64	12	129	0.23
terbufos	0.50	0.57	6.8	113	0.11
terbutryn	0.50	0.46	24	93	0.34
2,2',4,4'-tetrachlorobiphenyl	0.50	0.46	7.4	91	0.10
toxaphene ^a	10	12	2.7	122	1.0
tridimeton	0.50	0.71	7.3	142	0.16
2,4,5-trichlorobiphenyl	0.50	0.48	4.3	97	0.066
tricyclazole	0.50	0.45	14	130	0.27
trifluralin	0.50	0.59	7.8	117	0.14
vernalate	0.50	0.50	3.2	99	0.047

- ^a Six replicates
- ^b Seven replicates in fortified tap water.
- ^c Seven replicates

Table 525.2

ACCURACY AND PRECISION DATA FROM EIGHT DETERMINATIONS AT 5 µg/L IN REAGENT WATER OF POORLY CHROMATOGRAPHED NITROGEN
AND PHOSPHOROUS CONTAINING PESTICIDES

Compound	Ion Trap Mass Spectrometer				Quadrupole Mass Spectrometer			
	Cartridge		Disk		Cartridge		Disk	
	Relative Standard Deviation (%)	Mean Method Accuracy (% of True Conc.)	Relative Standard Deviation (%)	Mean Method Accuracy (% of True Conc.)	Relative Standard Deviation (%)	Mean Method Accuracy (% of True Conc.)	Relative Standard Deviation (%)	Mean Method Accuracy (% of True Conc.)
fenamiphos	7.7	79	4.5	108	6.1	103	8.8	124
fenarimol	2.0	104	10	110	6.5	126	5.5	150
fluridone	2.5	105	2.3	104	3.6	102	4.5	116
hexazinone	4.2	106	9.7	116	5.3	104	8.3	127
influrazon	4.1	111	9.6	119	3.2	98	11.1	113
stirofos	8.2	114	12	124	4.1	110	11.1	125
tebuthiuron	9.5	119	5.3	145	13	136	8.6	182
riademetan	7.8	115	10	128	3.7	100	9.8	118
tricyclazole	16	81	9.5	99	19	92	12	137

C





**First
Environmental
Laboratories, Inc.**

1600 Shore Road • Naperville, Illinois 60563 • Phone (630) 778-1200 • Fax (630) 778-1233
IEPA Certification #100292

PRACTICAL QUANTITATION LIMITS FOR SOIL AND SEDIMENT

Analyte	PQL	Units
Solids, Total		%

Volatile Organic Compounds Method 8260A

Acetone	10.0	ug/kg
Benzene	5.0	ug/kg
Bromodichloromethane	5.0	ug/kg
Bromoform	5.0	ug/kg
Bromomethane	10.0	ug/kg
2-Butanone	10.0	ug/kg
Carbon disulfide	5.0	ug/kg
Carbon tetrachloride	5.0	ug/kg
Chlorobenzene	5.0	ug/kg
Chlorodibromomethane	5.0	ug/kg
Chloroethane	10.0	ug/kg
Chloroform	5.0	ug/kg
Chloromethane	10.0	ug/kg
1,1-Dichloroethane	5.0	ug/kg
1,2-Dichloroethane	5.0	ug/kg
1,1-Dichloroethene	5.0	ug/kg
cis-1,2-Dichloroethene	5.0	ug/kg
trans-1,2-Dichloroethene	5.0	ug/kg
1,2-Dichloropropane	5.0	ug/kg
cis-1,3-Dichloropropene	5.0	ug/kg
trans-1,3-Dichloropropene	5.0	ug/kg
Ethyl benzene	5.0	ug/kg
2-Hexanone	10.0	ug/kg
4-Methyl-2-pentanone	10.0	ug/kg
Methylene chloride	5.0	ug/kg
Styrene	5.0	ug/kg



**First
Environmental
Laboratories, Inc.**

1600 Shore Road • Naperville, Illinois 60563 • Phone (630) 778-1200 • Fax (630) 778-1233
IEPA Certification #100292

PRACTICAL QUANTITATION LIMITS FOR SOIL AND SEDIMENT

Analyte	PQL	Units
1,1,2,2-Tetrachloroethane	5.0	ug/kg
Tetrachloroethene	5.0	ug/kg
Toluene	5.0	ug/kg
1,1,1-Trichloroethane	5.0	ug/kg
1,1,2-Trichloroethane	5.0	ug/kg
Trichloroethene	5.0	ug/kg
Vinyl Acetate	10.0	ug/kg
Vinyl Chloride	10.0	ug/kg
Xylenes (total)	5.0	ug/kg

Base-Neutral/Acid Compounds Method 8270B

Acenaphthene	330	ug/kg
Acenaphthylene	330	ug/kg
Anthracene	330	ug/kg
Benzidine	330	ug/kg
Benzo[a]anthracene	330	ug/kg
Benzo[b]fluoranthene	330	ug/kg
Benzo[k]fluoranthene	330	ug/kg
Benzo[g,h,i]perylene	330	ug/kg
Benzo[a]pyrene	330	ug/kg
Benzoic Acid	330	ug/kg
Benzyl alcohol	330	ug/kg
bis(2-Chloroethoxy)methane	330	ug/kg
bis(2-Chloroethyl)ether	330	ug/kg
bis(2-chloroisopropyl)ether	330	ug/kg
bis(2-Ethylhexyl)phthalate	330	ug/kg
4-Bromophenyl-phenylether	330	ug/kg
Butylbenzylphthalate	330	ug/kg



**First
Environmental
Laboratories, Inc.**

1600 Shore Road • Naperville, Illinois 60563 • Phone (630) 778-1200 • Fax (630) 778-1233
IEPA Certification #100292

PRACTICAL QUANTITATION LIMITS FOR SOIL AND SEDIMENT

Analyte	PQL	Units
4-Chloroaniline	330	ug/kg
4-Chloro-3-methylphenol	330	ug/kg
2-Chloronaphthalene	330	ug/kg
2-Chlorophenol	330	ug/kg
4-Chlorophenyl-phenylether	330	ug/kg
Chrysene	330	ug/kg
Dibenz[a,h]anthracene	330	ug/kg
Dibenzofuran	330	ug/kg
1,2-Dichlorobenzene	330	ug/kg
1,3-Dichlorobenzene	330	ug/kg
1,4-Dichlorobenzene	330	ug/kg
3,3'-Dichlorobenzidine	660	ug/kg
2,4-Dichlorophenol	330	ug/kg
Diethylphthalate	330	ug/kg
2,4-Dimethylphenol	330	ug/kg
Dimethylphthalate	330	ug/kg
Di-n-butylphthalate	330	ug/kg
4,6-Dinitro-2-methylphenol	1,600	ug/kg
2,4-Dinitrophenol	1,600	ug/kg
2,4-Dinitrotoluene	330	ug/kg
2,6-Dinitrotoluene	330	ug/kg
Di-n-octylphthalate	330	ug/kg
Fluoranthene	330	ug/kg
Fluorene	330	ug/kg
Hexachlorobenzene	330	ug/kg
Hexachlorobutadiene	330	ug/kg
Hexachlorocyclopentadiene	330	ug/kg
Hexachloroethane	330	ug/kg
Indeno[1,2,3-cd]pyrene	330	ug/kg
Isophorone	330	ug/kg
2-Methylnaphthalene	330	ug/kg



**First
Environmental
Laboratories, Inc.**

1600 Shore Road • Naperville, Illinois 60563 • Phone (630) 778-1200 • Fax (630) 778-1233
IEPA Certification #100292

PRACTICAL QUANTITATION LIMITS FOR SOIL AND SEDIMENT

Analyte	PQL	Units
2-Methylphenol	330	ug/kg
3&4-Methylphenol	330	ug/kg
Naphthalene	330	ug/kg
2-Nitroaniline	1,600	ug/kg
3-Nitroaniline	1,600	ug/kg
4-Nitroaniline	1,600	ug/kg
Nitrobenzene	330	ug/kg
2-Nitrophenol	1,600	ug/kg
4-Nitrophenol	1,600	ug/kg
N-Nitrosodimethylamine	330	ug/kg
N-Nitroso-di-n-propylamine	330	ug/kg
n-Nitrosodiphenylamine	330	ug/kg
Pentachlorophenol	1,600	ug/kg
Phenanthrene	330	ug/kg
Phenol	330	ug/kg
Pyrene	330	ug/kg
1,2,4-Trichlorobenzene	330	ug/kg
2,4,5-Trichlorophenol	660	ug/kg
2,4,6-Trichlorophenol	330	ug/kg



**First
Environmental
Laboratories, Inc.**

1600 Shore Road • Naperville, Illinois 60563 • Phone (630) 778-1200 • Fax (630) 778-1233
IEPA Certification #100292

PRACTICAL QUANTITATION LIMITS FOR SOIL AND SEDIMENT

Analyte	PQL	Units	Method
Aluminum	5.0	mg/kg	6010A
Antimony	1.0	mg/kg	6010A
Arsenic	0.2	mg/kg	6010A
Barium	0.1	mg/kg	6010A
Beryllium	0.1	mg/kg	6010A
Cadmium	0.1	mg/kg	6010A
Calcium	10	mg/kg	6010A
Chromium	0.1	mg/kg	6010A
Cobalt	0.1	mg/kg	6010A
Copper	0.1	mg/kg	6010A
Iron	1.0	mg/kg	6010A
Lead	0.2	mg/kg	6010A
Magnesium	10	mg/kg	6010A
Manganese	0.1	mg/kg	6010A
Mercury	0.05	mg/kg	7470A
Nickel	0.1	mg/kg	6010A
Potassium	10	mg/kg	6010A
Selenium	0.2	mg/kg	6010A
Silver	0.1	mg/kg	6010A
Sodium	10	mg/kg	6010A
Thallium	1.0	mg/kg	6010A
Vanadium	1.0	mg/kg	6010A
Zinc	0.5	mg/kg	6010A
Cyanide	0.10	mg/kg	9010A

D



HYDROLAB[®]

Multiparameter Water Quality Monitoring Instruments

– Operating Manual –



DATASONDE[®] 3

Multiprobe Logger

Operating Manual

January 1994



HYDROLAB CORPORATION

P.O. Box 50116 • Austin, TX 78763

800-949-3766 or 512-255-8841

This operating manual contains trade secrets and confidential information which are proprietary to Hydrolab Corporation. Its use or disclosure in whole or part without the express written permission of Hydrolab Corporation is prohibited.

This operating manual is also an unpublished work protected under the copyright laws of the United States of America. If this work becomes published, the following notice shall apply:

Copyright © 1993 Hydrolab Corporation
All Rights Reserved

HL#003049, REVISION F

DataSonde® 3 Multiprobe Logger Operating Manual

ADDENDUM

April 1995

(upgrades DS3 Multiprobe Operating Manual to Revision H)

1. SOM

A. Default Format

The opening header has been modified to indicate the new software revision and copyright notice:

```

Hydrolab DataSonde 3 V1.70
(C)opyright 1995 Hydrolab Corporation
NO LABEL
  
```

Time	Temp	pH	SpCond	Salin	DO	DO	Redox	Depth	Turb	Batt
HHMMSS	deg C	units	mS/cm	ppt	%Sat	mg/l	mV	meters	NTU	volts

The Standard Operating Mode (SOM) fits all available parameters on a single 80 column line by compressing the special add-on characters for each parameter to one column. The following table shows how the special characters are prioritized:

Calibrated?	Compensated?	Character
No	No	*
No	Yes	*
Yes	No	@
Yes	Yes	blank

For example, if conductivity was not calibrated and not temperature compensated, "*" would appear after the conductivity reading. When conductivity is calibrated, the "*" would then be replaced by "@". If conductivity is then compensated for temperature effects, the "@" would be replaced by a blank. The compression is only in effect if all parameters are enabled. If one or more parameters are disabled, then two positions will be used for the add-on characters as shown in the following table:

Calibrated?	Compensated?	Characters
No	No	*@
No	Yes	*blank
Yes	No	@blank
Yes	Yes	blank blank

B. Custom Formats

The SOM format for your multiprobe can be changed to simulate the formats of previous multiprobe releases. This feature allows you to configure a newly released multiprobe for compatibility with older versions of Hydrolab Scout[®]2 Displays, Surveyor[®]3 Display Loggers, Analog Converters, and third party SDI-12 Controllers. Please contact Hydrolab Customer Service for further compatibility information.

The format of the SOM can be modified by typing a control-D from the Variables Menu:

TC%ODYAELHBSXUFR?: Data Format

ABC?: ?

(A)->ITPCS%ORDB,

(B)->ITPCS(% or O)YRDB,

(C)->ITPCS%ORDYB,

or (Escape or Ctrl X to Cancel)

Select:

When you are using the expert menus, typing a "?" at any menu will produce an expanded version of that menu for help in making your selection. Option C is the normal or default SOM format that includes both DO parameters and adds turbidity between the depth and battery parameters. The special characters are compressed if all parameters are enabled.

Typing an "A" will select a SOM format that is similar to the format used in DataSonde 3 Multiprobes with software versions up to 1.32, prior to the introduction of the turbidity parameter. This format includes both the DO %sat and DO mg/L readings but does not include the turbidity parameter. Do not select this format if you intend to measure turbidity. This format appears as follows:

Hydrolab DataSonde 3 V1.70

(C)copyright 1995 Hydrolab Corporation

No Label

Time	Temp	pH	SpCond	Salin	DO	DO	Redox	Depth	Batt
HHMMSS	deg C	units	mS/cm	ppt	%Sat	mg/l	mV	meters	volts

Typing a "B" will select a SOM format that is similar to the format used by DataSonde 3 Multiprobes with software versions 1.40 through 1.41, when the turbidity parameter was introduced:

Hydrolab DataSonde 3 V1.70

(C)copyright 1995 Hydrolab Corporation

No Label

Time	Temp	pH	SpCond	Salin	DO	Turb	Redox	Depth	Batt
HHMMSS	deg C	units	mS/cm	ppt	%Sat	NTU	mV	meters	volts

This format replaces the DO mg/L parameter with the turbidity parameter. A menu entry in the Oxygen Variables allows you to display either the DO %sat or the DO mg/L reading.

Your selection will be stored in the multiprobe so that you do not need to repeat this procedure until you need to change your selection. Your selection will also appear in the Variables Report.

II. Parameter Enhancements

The DataSonde 3 Multiprobe now incorporates some additional features to give you some options on salinity and specific conductance computations. These features can only be accessed using a computer or terminal equipment.

A. Salinity

The DataSonde 3 Multiprobe normally computes salinity using an algorithm adapted from the United States Geological Survey Water-Supply Paper 2311 titled "Specific Conductance: Theoretical Considerations and Application to Analytical Quality Control" and other sources. This salinity algorithm is only defined for salinity values in the 30 to 40 ppt range (mild concentrations and dilutions of sea water). Salinity is calculated directly from specific conductance values using the following equation:

$$S = a_1 C^4 + a_2 C^3 + a_3 C^2 + a_4 C + a_5$$

where

C = specific conductance, millisiemens/cm.

$$a_1 = 5.9950 \times 10^{-4},$$

$$a_2 = -2.3120 \times 10^{-5},$$

$$a_3 = 3.4346 \times 10^{-3},$$

$$a_4 = 5.3532 \times 10^{-1}, \text{ and}$$

$$a_5 = -1.5494 \times 10^2.$$

This is the salinity algorithm used by Hydrolab multiprobes since May of 1991.

The DataSonde 3 Multiprobe can optionally compute salinity using the Practical Salinity Scale (1978). This algorithm is defined for salinities ranging from 2 to 42 and is calculated using conductivity values corrected to a temperature of 15 °C. This algorithm is described in section 2520B of "Standard Methods for the Examination of Water and Wastewater", 18th edition. The DataSonde 3 Multiprobe currently does not implement the 0 - 40 extension.

The Practical Salinity Scale may be selected by typing control-N from the Variables Menu:

TC%ODYAELHBSXUFR?: Salinity Computation

AB?: ?

(A)->Method 1,

(B)->Method 2,

or (Escape or Ctrl X to Cancel)

Select:

When you are using the expert menus, typing a "?" at any menu will produce an expanded version of that menu for help in making your selection. Typing an "A" from the Salinity Computation Menu will select the USGS 2311 based algorithm; "B" will select the Practical Salinity Scale. Your selection will be stored in the multiprobe so that you do not need to repeat this procedure until you need to change your selection. Your selection will also appear in the Variables Report.

B. Specific Conductance

The DataSonde 3 Multiprobe can display specific conductance using measurements optimized for fresh or saltwater. The saltwater measurements are implemented using the saltwater cell block and setting "Salt" in the Conductivity Variables Menu (see section 2.6.2). Specific conductance (conductivity at 25 °C) is calculated from conductivity values using the following function based on standard seawater:

$$C = k(b_1T^7 + b_2T^6 + b_3T^5 + b_4T^4 + b_5T^3 + b_6T^2 + b_7T + b_8)$$

where

C = specific conductance,

k = measured conductivity,

T = temperature, °C,

$b_1 = 1.2813 \times 10^{-11}$,

$b_2 = -2.2129 \times 10^{-9}$,

$b_3 = 1.4771 \times 10^{-7}$,

$b_4 = -4.6475 \times 10^{-6}$,

$b_5 = 5.6170 \times 10^{-4}$,

$b_6 = 8.7699 \times 10^{-4}$,

$b_7 = -6.1736 \times 10^{-2}$, and

$b_8 = 1.9524$.

The freshwater measurements are implemented using the freshwater cell block and setting "Fresh" in the Conductivity Variables Menu (see section 2.6.2). Specific conductance is calculated from conductivity values using the following function based on 0.01N KCl:

$$C = k(c_1T^5 + c_2T^4 + c_3T^3 + c_4T^2 + c_5T + c_6)$$

where

C = specific conductance,

k = measured conductivity,

T = temperature, °C,

$c_1 = 1.4326 \times 10^{-9}$,

$c_2 = -6.0716 \times 10^{-4}$,

$c_3 = -1.0665 \times 10^{-5}$,

$c_4 = 1.0943 \times 10^{-3}$,

$c_5 = -5.3091 \times 10^{-2}$, and

$c_6 = 1.8199$.

You can use the Variables Menu (section 2.6.2) to disable temperature compensation so that the multiprobe displays conductivity instead of specific conductance.

Normally, the multiprobe automatically selects the appropriate fresh or saltwater temperature compensation function based on the type of cell block you have installed. The DataSonde 3 Multiprobe now provides you some additional options for conductivity temperature compensation. These options can be accessed from the Variables Menu by typing a control-C:

**TC%ODYAELHBSXUFR?: Conductivity Temperature Compensation
ABCD?: ?**

(A)->Comp 1,
(B)->Comp 2,
(C)->Comp 3,
(D)->Comp 4,
or (Escape or Ctrl X to Cancel)
Select:

When you are using the expert menus, typing a "?" at any menu will produce an expanded version of that menu for help in making your selection. The Comp 1 option is selected by typing an "A". This is the normal method of conductivity temperature compensation that allows the multiprobe to automatically select the fresh or saltwater function based on the type of cell block you have installed.

Typing a "B" will select the Comp 2 option which forces the multiprobe to always use the freshwater temperature compensator regardless of the type of cell block you have installed.

Typing a "C" will select the Comp 3 option which forces the multiprobe to compute specific conductance using the method described in section 2510 of "Standard Methods for the Examination of Water and Wastewater", 18th edition. This method calculates conductivity at 25°C using the following function:

$$C = k(1 + 0.0191(T-25))^{-1}$$

where

C = specific conductance,

k = measured conductivity,

T = temperature, °C.

Typing a "D" will select the Comp 4 option which forces the multiprobe to always use the saltwater temperature compensator regardless of the type of cell block you have installed.

Your selection will be stored in the multiprobe so that you do not need to repeat this procedure until you need to change your selection. Your selection will also appear in the Variables Report.

Regardless of the compensation function that you select, all of the conductivity variables must still be properly set as described in section 2.6.2. The Fresh/Salt variable must correspond to the type of cell block you have installed, and temperature compensation must be enabled to allow specific conductance to be computed using the option you have selected above.

C. DO mg/L

The DataSonde 3 Multiprobe will indicate an over-range (#s) on DO %sat and DO mg/L when DO %sat becomes greater than 200. However, a DO %sat reading of 200 does not always correspond to the maximum DO mg/L reading of 20 due to the temperature variance of oxygen solubility in water. This is the case when you are measuring in highly oxygenated, warm water.

You can prevent over-range DO %sat readings from affecting DO mg/L readings; call Hydrolab Customer Service for more information.

DataSonde® 3 Multiprobe Operating Manual

ADDENDUM

December 1994

(upgrades DataSonde 3 Multiprobe Operating Manual to Revision G)

THIS ADDENDUM UPDATES THE DS3 MULTIPROBE SOFTWARE TO V1.60.

1. SOM

The opening header was modified to indicate the new software revision and copyright notice:

Hydrolab DataSonde 3 V1.60
(C)opyright 1994 Hydrolab Corporation
No Label

Time	Temp	pH	SpCond	Salin	DO	DO	Redox	Depth	Turb	Batt
HHMMSS	deg C	units	mS/cm	ppt	% sat	mg/l	mV	meters	NTU	volts

The Standard Operating Mode (SOM) has been modified to include the DO mg/L parameter.

In order to fit the DO mg/L parameter on an 80 column line, the special add-on characters for each parameter have been compressed to one character. For example, if conductivity was not calibrated and not temperature compensated, "~~" would appear after the conductivity reading. When conductivity is calibrated, the "~~" would then be replaced by "@". If conductivity is then compensated for temperature effects, the "@" would be replaced by a blank.

The compression is only in effect if all parameters are enabled. If one or more parameters are disabled, then two positions will be used for the add-on characters as in previous software releases.

2. Parameter Changes

A. Salinity

Salinity is now computed using the Practical Salinity Scale 1978 as outlined in Standard Methods. Using this scale, a KCl solution of 32.4356 g/kg at 15°C would have a salinity of 35. The scale is intended for salinities ranging from 2 to 42, although the DataSonde 3 will compute salinity readings ranging from 0 to about 72.

B. Conductivity

The salt water temperature compensation function for conductivity has been removed. The fresh water temperature compensation function is used regardless of the setting in the fresh/salt conductivity variable. The fresh/salt variable must still however, correspond to the type of cell block that is installed.

C. DO mg/L

The measurement range of the DO mg/L parameter has been expanded to range from 0 to 20 mg/L regardless of the DO %sat parameter. The DataSonde 3 Multiprobe indicates a parameter over-range condition based on the maximum attainable value for that parameter. Previous multiprobe releases would over-range the DO mg/L parameter when the DO %sat parameter reached 200. However, a DO %sat reading of 200 does not always correspond to a DO mg/L reading of 20 due to temperature effects.

3. Parameter Calibration Changes

A. DO

Calibration acceptability for DO mg/L and DO %sat has been improved for high altitude applications.

B. Salinity/TDS/Resistivity

Salinity, TDS, and resistivity will now calibrate correctly when the conductivity units are set to microsiemens/cm. Previous software releases would try to divide the standard by 1000 resulting in a "Out of tolerance, calibration is not saved!" message even though the calibration standard was valid.

4. Miscellaneous Menu Changes

A. Parameters

The % entry has been added to the Parameter Menu to allow the DO %sat parameter to be enabled or disabled.

B. Oxygen Variables

The %O menu has been removed from the Oxygen Variables Menu since both DO parameters are now available.

5. DataSonde 3 SDI-12 Interface Update

Please see "Addendum, Rev A" located in Appendix 5 at the back of this manual for changes to the SDI-12 Interface for compatibility with DataSonde 3 Multiprobe Software Versions 1.60 and higher.

Appendix 5: "Using the DataSonde 3 SDI-12 Interface"

ADDENDUM

December 1994

(upgrades Appendix 5 to Revision A)

**THIS ADDENDUM UPDATES THE SDI-12 OPERATION FOR COMPATIBILITY
WITH DATASONDE 3 MULTIPROBE SOFTWARE VERSIONS 1.60 OR HIGHER**

An SDI-12 extended command has been added so that the measurement delay can be set using the SDI-12 interface. The measurement delay is the amount of time (seconds) that the DataSonde 3 requires to collect a set of readings. The command format is "aLttt!", where "a" is the SDI-12 address of the DataSonde 3, and "ttt" is the three digit delay time in seconds. The default setting is 30 seconds and the maximum allowable value is 994 seconds.

The following table shows the sequence of water quality parameters available on the SDI-12 Interface.

DataSonde 3 Software Version*

V1.00 - V 1.32	V1.40 - V1.59	V1.60+
Temp	Temp	Temp
pH	pH	pH
Cond/Res	Cond/Res	Cond/Res
Salin/TDS	Salin/TDS	Salin/TDS
DO %sat	DO**	DO %sat
DO mg/L	Turb	DO mg/L
Redox	Redox	Redox
Depth/Level	Depth/Level	Depth/Level
Batt	Batt	Turb

* DataSonde 3 Multiprobes with software versions up to, but not including, version 1.60 would not send a water quality parameter on the SDI-12 Interface if that parameter was disabled in the SOM. Version 1.60 software will send that parameter on the SDI-12 Interface even if it is disabled in the SOM.

** This parameter can be either DO %sat or DO mg/L based on the current DataSonde 3 variable settings.

DataSonde³ 3 Multiprobe Operating Manual
ADDENDUM
October 1993

(upgrades DataSonde 3 Multiprobe Operating Manual to Revision F)

This addendum updates the DS3 manual for the addition of turbidity. It assumes knowledge of the DS3 manual. The section numbers reference the pertinent section of the manual which is modified or updated.

PART TWO: DATA DISPLAY & MENUS

2.1 Data Display

In order to add turbidity to the SOM, the DO %Sat and DO mg/L outputs were consolidated into a single column. Only one of these two DO outputs may be displayed at a time. Within the DO variables menu, the operator can select the DO output most important to his work.

2.4 Parameters

With the DO output consolidation, '%' is no longer an option of the Parameter menu. Selecting 'O' will select DO %Sat or DO mg/L. Which is displayed depends on the operator selection in the DO variables menu.

Turbidity can be enabled or disabled by selecting the 'Y' option on the parameters menu, then selecting whether to enable or disable.

2.5 Calibrate

Calibration of turbidity has been added to the Calibrate menu.

2.5.11 Turbidity

From the Calibrate menu, type a Y to get:

Enter Turbidity (NTU):

Always calibrate with "turbidity free" water (the turbidity system's zero) before calibrating with a second standard (the turbidity system's slope). If your readings for "turbidity free" water had stabilized in the SOM, you would now type in "0"<enter> to automatically calibrate the turbidity system zero. The

multiprobe will only accept zero for the zero setting. At this point you will be returned to the SOM so that you can begin monitoring turbidity readings for the second slope-setting standard. Once readings stabilize, you can again access the Basic Menu, then the Calibrate menu, then type a Y to get:

Enter Turbidity (NTU):

again. So type the value of your slope standard (such as 90 NTU) and hit the return key. The slope will be set and you will be returned to the SOM.

2.6 Variables

An additional DO Variables option has been added, and turbidity has been added to the Variables menu.

2.6.4 DO

Typing an O from the Variables menu will let you specify which DO type to display:

(%)Sat,
D(O),
or (Escape or Ctrl X to cancel)
Select:

Type a % if you wish to see DO %Sat readings displayed or type an O if you wish to see DO mg/L readings displayed.

After this selection, you will be asked about membrane type and salinity correction as before. See section 2.6.4 in the operator's manual for more details.

2.6.15 Turbidity

Typing a Y from the variables menu will let you specify details about your Turbidity measurements:

(R)atio,
(N)ephelometric only,
or (Escape or Ctrl X to cancel)
Select:

Type an R if you wish to operate in the ratio mode. Ratio mode measures the nephelometric sensor and the transmissive sensor. The transmissive measurement corrects system linearity at high turbidity values (most notably > 500 NTU). Type an N if you wish to operate in the nephelometric only mode. See Technical Notes for more details.

NOTE: Any calibration performed on the ratio mode or nephelometric will not suffice as a ratio calibration. If you choose to change from one mode to the other, the sensor must be recalibrated for the new mode.

After typing R or N, you will be asked:

(A)uto range,
(H)igh range,
(L)ow range,
or (Escape or Ctrl X to cancel)
Select:

Typing an A will allow the DS3 to automatically select the appropriate display range. Typing an H will mean that all output will be displayed in the high-range format (e.g., 545) with loss of resolution in the lower readings. Typing an L will mean that all output will be displayed in the low-range format (e.g., 54.5) with no readings of over 100 NTU values. This feature allows the user of data collection platforms and certain types of data recorders to compress data into a more efficient format.

After typing A, H, or L, you will be returned to the SOM.

2.10 Identify

This function causes the DS3 to print:

Hydrolab DS3 VX.XX.WW TCPSOYRDB

This provides the DS3 software revision and the parameters which are installed in the DS3. Note that O represents both DO %Sat and DO mg/L and Y represents Turbidity.

The DS3 level circuitry has a second microprocessor to control the data acquisition. The WW is the software revision for this microprocessor. The X.XX is the software revision for the main microprocessor which controls the user interface, calibration, variables, logging, etc.

NOTE: Some DS3s will continue to display the software revision as VX.XX instead of VX.XX.WW. DS3s with turbidity or turbidity level circuitry will display as VX.XX.WW.

2.12 Special Symbols in the Display or Printout

Turbidity

As with other parameters, an asterisk (*) means turbidity has never been completely calibrated. To remove this flag both the zero and slope calibrations must be completed.

An @ next to the turbidity reading indicates that the data displayed is based on the nephelometric only mode. Absence of the @ implies the reading is based on the ratio mode.

A ? adjacent to the turbidity reading has two possible meanings. Most likely the ambient light as seen by the sensors is above the acceptable threshold acceptable. The other possibility for the ? is that the sensor LED has failed. See Technical Notes for further details.

PART THREE: MAINTENANCE & CALIBRATION

3.12 Turbidity

Maintenance

Turbidity sensor maintenance is required when any of the lenses have a visible coating. To clean the sensor, first rinse with water directed at the lens to remove any large caked deposits. Then remove the retainer/guard by unscrewing the black nylon screw. DO NOT REMOVE the lens. The lens can be cleaned in place by wiping with a very clean, soft, non-abrasive cloth wet with rubbing alcohol. After cleaning, rinse the sensor and retainer/guard with water, and reattach the retainer/guard.

The frequency of maintenance depends upon the rate and type of fouling, and the deployment technique. These are factors which must be evaluated by the operator.

Calibration Standards

First, prepare "turbidity-free" water for the zero calibration. "Turbidity-free" water may be purchased from many supply houses or created by passing distilled water through a membrane filter with 0.2 mm precision-sized holes.

Dilutions of formazin or styrene divinylbenzene beads (AMCO-AEPA-1) may be used for the slope calibration.

CAUTION: *Formazin is a suspected carcinogen. A material safety datasheet has been included with the formazin contained in your maintenance kit. Please read, understand, and follow all safety instructions before using this material.*

Formazin may be prepared as per Standard Methods or purchased from many supply houses. AMCO-AEPA-1 is available from Advanced Polymer Systems of Redwood, California. The dilution may be performed using standard lab glassware and the following formula:

$$\text{Standard} = \text{STOCK}_{\text{NTU}} \cdot \text{STOCK}_{\text{VOL}} / (\text{STOCK}_{\text{VOL}} + \text{TF}_{\text{VOL}})$$

where:

$\text{STOCK}_{\text{NTU}}$ is the NTU value of the stock,

$\text{STOCK}_{\text{VOL}}$ is the volume of stock used,

and TF_{VOL} is the volume of "turbidity-free" water used.

Note that the final volume of the standard is $\text{STOCK}_{\text{VOL}} + \text{TF}_{\text{VOL}}$. For example, if I want 500 mL of 90 NTU as my slope standard and I am using 4000 NTU stock, then I would add 11.3 mL of stock to 489 mL of turbidity free water. Generally, good measurement technique requires that standards at or near the expected field value be used for slope calibration.

NOTE: Ensure that the standard is well mixed prior to making the dilution. Failure to do so can create an inaccurate calibration and eventually ruin the quality of the stock standard.

Additional standards may be prepared to check the linearity and inter-ranging of the turbidity system. If so, all dilutions should originate from the same stock solution. Notice that the stock formazin solutions have a tolerance of +/- 5%, which even with a perfect instrument, could produce an apparent 10% error.

NOTE: Standard Methods recommends daily preparation of formazin dilutions.

Technique

Calibration can be performed in a calibration cup or in a stirred vessel. The latter is preferred for high turbidity standards or time intensity studies. Well-mixed 900 NTU formazin can settle to 350 NTU in 20 minutes.

Calibration Cup

Rinse with turbidity free water several times and then dry the sensors as much as possible. Any residue or fluids left behind can affect the zero and slope calibrations. Next, fill the calibration cup with turbidity-free water and wait for equilibrium (usually 1 to 2 minutes). While filling, check for bubbles trapped in the turbidity sensor. Then execute the turbidity calibration with a standard value of 0 NTUs.

Discard the turbidity free water and again dry the sensors as much as possible. Now fill the calibration cup with the well-mixed standard and wait for equilibrium (again usually 1 to 2 minutes). Then execute the turbidity calibration with the value of the standard used.

Stirred Solution

Rinse with turbidity free water several times and then dry the sensors as much as possible. Invert the DS3 sensors into the stirred vessel of turbidity-free water. Keep the turbidity sensor as close to the center of the vessel as possible. Check to make sure no bubbles are trapped by the guard/retainer.

Wait for equilibrium and then execute the turbidity calibration with a standard value of 0 NTUs. Repeat for the slope standard.

Dilutions may be performed in a similar manner by adding stock, allowing equilibrium, and noting the result.

PART FOUR: DEPLOYMENT

Bubbles

When lowering the sensors into the water body, try to keep the "U" shaped portion of the turbidity sensor pointed toward the water's surface until the sensor is completely submerged. This technique will minimize the chances of trapping bubbles in the sensor retainer/guard. Bubbles have optical properties such that they cannot be distinguished from turbidity particles in the water.

Probe Guard

The orientation of the guard can affect turbidity readings. A 6% non-linearity can be observed by rotating the guard (on weighted sensor guard or stirrer) by only 30 degrees from the optimum location.

The optimum location is noted by a mark on the side of the sensor bottom cap. The guard should be rotated until one of its "webs" is aligned with this mark. If the mark is missing or damaged, the optimum location can be found by rotating the guard until a web is just about to enter the "U-shaped" portion of the turbidity sensors view.

Note that at this position the adjacent web has just left the turbidity sensor's field of vision.

Non-turbidity units have harder o-rings which only allow 30 degrees of rotation after the guard reaches the o-ring. The o-ring installed in turbidity DS3s is a softer durometer which will allow 90 degrees of rotation.

Objects

Try to secure the DS3 where the turbidity sensor will not "see" other objects. These object include the dock, brush, cables, etc. During operation, water currents can cause the DS3 to move toward and away from these objects, creating strange turbidity results.

Orientation

If possible, orient the DS3 where the "U-shaped" portion of the turbidity sensor is directed away from the surface of the water. Otherwise, settleable solids (as contrasted with suspended solids) may accumulate on one or more of the lens surfaces. Such fouling will decrease the useful deployment time.

PART FIVE: TECHNICAL NOTES

Measurement Principle

The ISO-7027 specification calls for a nephelometric detector at 90 degrees from an infrared light source of 860 nm. The DS3 turbidity operated in nephelometric mode meets all these specifications except the light source is at 880 nm.

The ratio mode adds a transmissive correction to eliminate the "blinding out" phenomenon common in nephelometric instrumentation at high turbidities.

Selectin of mode is highly dependent upon your data requirements, adherence to any measurement specifications, and your primary range of measurement.

Ambient Light

The DS3 measures the sensor responses when the LED is on and when it is off. The difference between the on and off responses is used to eliminate the effects of ambient light and provide the turbidity measurements.

But there is a limit to the amount of ambient light which can be rejected. If the ambient light "saturates" the sensors, then the on and off responses to the LED will be nearly the same. Incorrect turbidity values are produced. The DS3 can detect when the ambient light is causing questionable turbidity data. When this condition is detected, a '?' is printed next to the turbidity data value.

The maximum ambient light threshold is equivalent to the amount of light reaching the sensor at a 1m submersion in "turbidity-free" water at full sunlight. At 1m deep, infrared light detected by the sensor is attenuated to 1%.

LED Variation

The LED output varies tremendously from part to part and over temperature. A third sensor was added to measure the light output and normalize the nephelometric and transmissive sensor responses.

Additionally, this third photodiode allows the DS3 to detect a faulty LED. The photodiode measures the LED output to insure proper operation. If the LED output becomes too low, a '?' is printed next to the turbidity data. To determine if the '?' is caused by ambient light or a faulty LED, shield the sensor from ambient light. If the '?' disappears, then the ambient light is too high. Otherwise, please contact Hydrolab Customer Service.

PART SIX: TROUBLESHOOTING

- **Cannot calibrate zero**

Is the standard turbidity-free water?
Has the sensor been properly cleaned?
Did you enter exactly zero for the standard?
Are bubbles trapped in the guard/retainer?

- **Cannot calibrate slope**

Were errors made in the dilution calculation/execution?
Was stock or dilution allowed to settle before use?
Is stock standard correct?
Has the sensor been properly cleaned?
Was the correct standard value entered?
Are bubbles trapped in the guard/retainer?

- **Dilution produces large errors**

Was dilution done from same stock standard as calibration?
Were errors made in the dilution calculations/execution?
Was stock or dilution allowed to settle before use?
Is stock standard correct?
Has error exceeded +/-5% of range at temperature of calibration?
Has the +/-5% inter-ranging error been considered?
Are bubbles trapped in the guard/retainer?

- **Turbidity values are noisy**

Are objects moving around the sensor?
Are the particles few and large?

- **Sensor Drift**

Has sensor fouled?
Has temperature changed? (+/-5% allowed over temperature)

- **Fouling**

Has the sensor been properly cleaned?
Has a proper maintenance interval been established?

- **'?' attached to turbidity data**

Has sensor been sheltered from ambient light?

Has the LED failed? (If so, please contact Hydrolab Customer Service at 800-949-3766 or 512-255-8841)

- **'@' attached to turbidity data**

Turbidity variables have been set to nephelometric only operation.

- **'*' attached to turbidity data**

Both turbidity zero and turbidity slope must be calibrated to remove the asterisk.

Appendix 2: SDI-12

No SDI-12 functions have changed. But, as in the SOM, only one of the two DO types can be extracted at a time. Turbidity, as in the SOM, replaces the removed DO in the data.

This change will only affect instruments extracting data from the DO fields in the data line.

Version 1.40
page 1 of 2
12/93

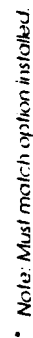
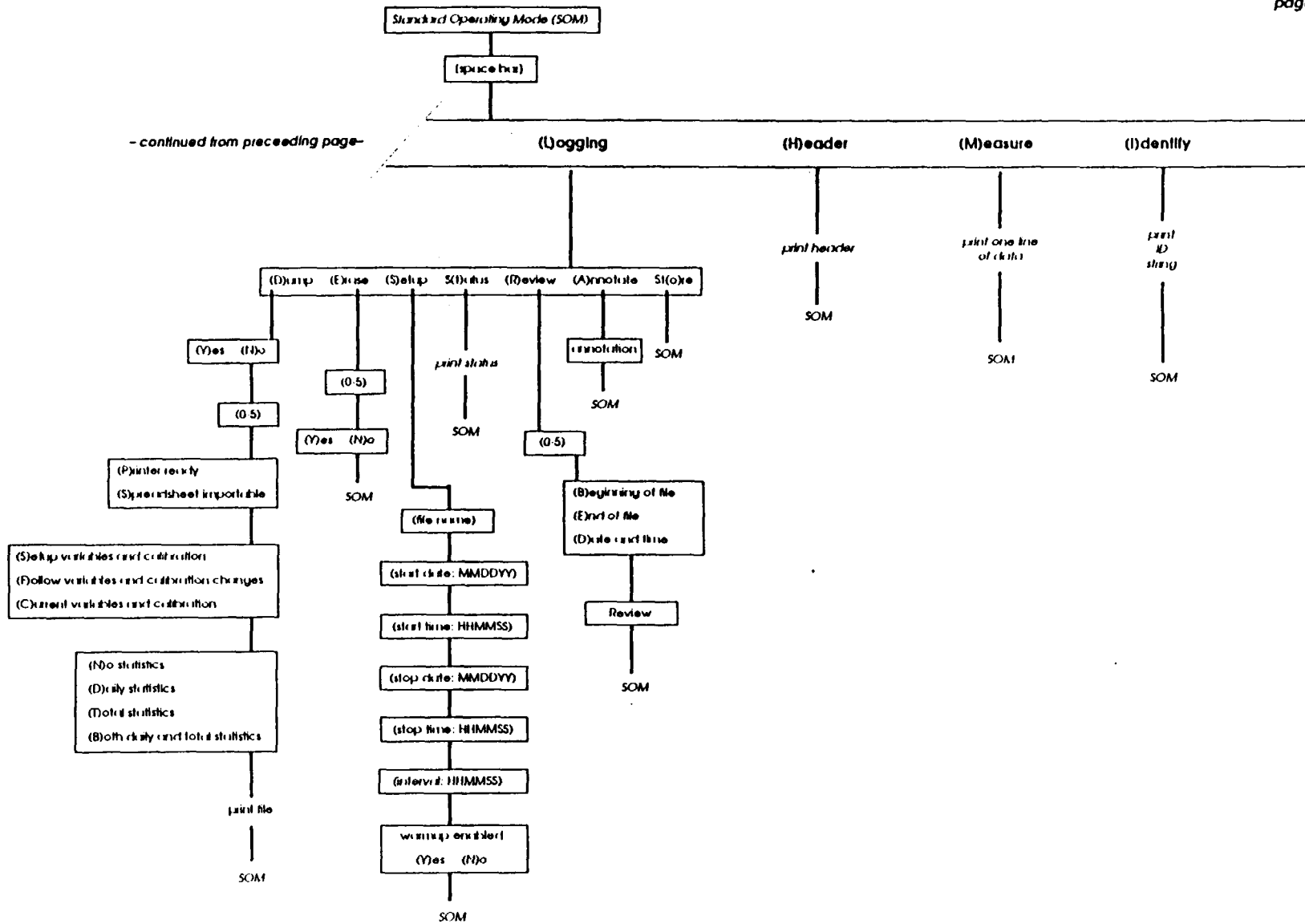


Figure 2.1 DataSonde 3 Menu Tree

Version 1.40
page 2 of 2
12/93



DataSonde[®] 3 Multiprobe Operating Manual

ADDENDUM

November 1992

(upgrades DataSonde 3 Multiprobe Operating Manual to Revision E)

- **Warning Label for Underwater Housings**

The following label should be found on the DataSonde 3 multiprobe.

WARNING!

Excess pressure may build up inside an underwater housing. This can cause the bottom cap, top cap, sensors, or other removable parts to pop out of the housing with enough force to cause serious injury to the eyes, face, or other parts of the body.

Whenever you loosen or tighten screws that hold removable parts, always point the parts away from your body and other people. HL#2060 Rev. 4

When disassembling a multiprobe (H20[®], H20[®]G, or DataSonde[®] 3), Stirrer, DataSonde 3 Submersible Battery Pack, or other underwater housing, always make sure that all removeable parts are pointed away from you and all other people. Removeable parts include top and bottom caps, cable connectors fixed to the housing, sensors mounted in the bottom cap, and all associated hardware.

Should you have any questions or need additional information with regard to this possible safety hazard, kindly contact our Customer Service Department at 1-800-949-3766 or 1-512-255-8841.

DataSonde® 3 Datalogger Operating Manual
ADDENDUM
September 1992

(upgrades DataSonde 3 Datalogger Operating Manual to Revision D)

This addendum covers improvements in the operation of the Hydrolab DataSonde 3 made by the software update from V1.23 to V1.30.

1. New Features

a) European Date Format:

Date entries for logging setup (see Section 7.5) are no longer restricted to the "month month-day day-year year" format (mm-dd-yy) format. The alternate date formats (dd-mm-yy and yy-mm-dd) can be selected by accessing the new Variables menu (see Section 2.6) entry Date (F)ormat, and then specifying which of the three formats you prefer. The format you select will show up in the SOM, Date/Time calibration, Log Status, and Log Dump (data, statistics, and spreadsheet).

b) Date, Time, Interval Editing:

Previously, any attempted entry of a faulty date, time, or interval would abort the entire setup procedure (see Sections 2.5 and 7.5). With V1.30, the operator has the opportunity to correct the faulty entry and continue with setup.

DataSonde[®] 3 Datalogger Operating Manual
ADDENDUM
August 1991

(upgrades DataSonde 3 Datalogger Operating Manual to Revision C)

1. Communication Baud Rate Enhancement

The original DataSonde 3 Datalogger (DS3) always communicated at 1200 baud. However, DS3s shipped after July, 1991 (software V1.22 and higher), allow the user to select from 300, 1200, 2400, 4800 and 9600 baud communications.

To change baud rate, follow the instruction set in Section 2.6.13 of the Operating Manual.

Once the baud rate is set, you will not have to set it again, even if you turn the DS3 off.

As usual, typing Escape or Control-X while still in the Variables menu will return the DS3 to the SOM without altering the baud rate.

Please note:

- If you see only random letters and figures where the parameter readings or menus should be, it is likely that your communications program is not set to the same baud rate as is your DS3. You must change the program to one of the other four baud rates to regain communication with the DS3.
- If your communications program cannot be set to a newly-specified baud rate, you will lose communication with your DS3. For instance, if you type U from the Variables menu and then type 3, your communications program must be settable to 300 baud (since that is what the DS3 now expects). If it is not, you cannot communicate with the DS3 to reset to another baud rate. If this improbable situation should happen to you, find another communications program, such as Procomm Plus[®], and reset the DS3 to 1200, 2400, 4800 or 9600 baud.
- If you have set your DS3 to 300, 2400, 4800 or 9600 baud, it will not communicate with the Hydrolab Surveyor[®] 3 Display/Logger. Reset to 1200 baud to regain use of this tool.

Foreword

The Hydrolab DataSonde³ 3 Water Quality Multiprobe Logger (DS3) is an on-line transmitter of in-situ temperature, pH, dissolved oxygen (both mg/L and percent saturation) conductivity (milliSiemens/cm, microSiemens/cm, or resistivity, K ohms/cm) and salinity (parts per thousand or total dissolved solids, mg/l), depth (either level or total depth), turbidity (NTUs), and redox readings in lakes, rivers, streams, process pipes, bays, estuaries, tanks, sewers, or other large or small water bodies. It can be used for profiling, sampling, or long-term monitoring (both on-line and unattended).

The multiprobe can be connected to any RS-232 receiving device, such as a personal computer, since its output is "printer ready"; the data is sent in engineering units and printed in orderly rows with descriptive headers. A standard internal SDI-12 interface also allows the DataSonde 3 Multiprobe to be used with certain data loggers (such as the Basic Data Recorder) and data collection platforms.

A user-selectable cycle interval determines how often the readings are automatically printed. Calibration is accomplished simply by immersing the sensors in standard solutions, waiting for stable readings, and briefly interrupting the data printout to set the new calibration points. Alternatively, the multiprobe can handle unattended monitoring with an internal and/or external power supply.

Either a Hydrolab Surveyor³ Display Logger or Scout² Display may serve as a watertight display for the DataSonde 3 Multiprobe. Contact Hydrolab Sales for more information on the Surveyor 3 or Scout 2.

Contents

Foreword	i
----------------	---

PART ONE: INTRODUCTION 1

1.1 Components and Assembly	1
<i>Figure 1.1 DataSonde 3 System Components</i>	3
1.2 Introductory Exercise	4
1.3 Important Note	9
1.4 The Performance Manual	10

PART TWO: DATA DISPLAY & MENUS 11

2.1 Data Display	11
2.2 The Menu Hierarchy	12
2.3 The Basic Menu	12
<i>Figure 2.1 DataSonde 3 Menu Tree</i>	13
2.4 Parameters	14
2.5 Calibrate	15
2.5.1 pH	16
2.5.2 Specific Conductance/Resistivity	16
2.5.3 Salinity/TDS	17
2.5.4 Dissolved Oxygen	18
2.5.5 Redox	18
2.5.6 Depth/Level	19
2.5.7 Label	19
2.5.8 Time	19
2.5.9 Interval	20
2.5.10 Message	21
2.6 Variables	21
2.6.1 Temperature	22
2.6.2 Specific Conductance/Resistivity	22
2.6.3 % Sat	24
2.6.4 DO	24
2.6.5 Depth/Level	25
2.6.6 Autolog	25
2.6.7 SDI-12 Address	26
2.6.8 SDI-12 Delay	26
2.6.9 Header	26
2.6.10 Buzzer	27
2.6.11 Stirrer	27
2.6.12 Expert	28
2.6.13 Baud Rate	28
2.6.14 Report	29
2.7 Logging	29
2.8 Header	30
2.9 Measure	30
2.10 Identify	30
2.11 Helpful Hints	31
2.12 Special Symbols in the Display or Printout	31

PART THREE: MAINTENANCE and CALIBRATION33

3.1	Parameter Selection	33
3.2	Remarks Concerning Sensor Preparation	34
3.3	Temperature	34
3.4	Specific Conductance and Salinity	34
	<i>Figure 3.1 Sensor Maintenance & Calibration Illustrations</i>	35
	<i>Figure 3.1 Sensor Maintenance & Calibration Illustrations (cont.)</i>	37
3.5	pH	38
3.6	Redox	40
3.7	Dissolved Oxygen	42
3.8	Depth	44
3.9	Care of the Multiprobe	44
3.10	Care of the Cables	45
3.11	Changing the Dissolved Oxygen/pH Sensor Batteries	45

PART FOUR: DEPLOYMENT49

4.1	Deployment in Open Waters	49
	4.1.1 Long-term Deployment in Open Waters	49
	4.1.2 Short-term Deployment in Open Waters	50
4.2	Using the Stirrer	50
4.3	Flow Cell Operation	51
4.4	Pressure and Temperature Extremes	51
4.5	Data Transmission Lines	51

PART FIVE: TECHNICAL NOTES53

5.1	Dissolved Oxygen Temperature and Salinity Corrections	53
5.2	The LoFlow Membrane Flow Optimization Factor	54
5.3	Dissolved Oxygen Altitude-Pressure Function	54
5.4	Specific Conductance	55
	5.4.1 Temperature Standardization	55
	5.4.2 Salinity Conversion	56
	5.4.3 Resistivity Conversion	56
	5.4.4 Total Dissolved Solids (TDS) Conversion	57
	5.4.5 Specific Conductance Less Than 0.2 Millisiemens/cm ?	57
	5.4.6 Correcting Depth for Specific Conductance	57
5.5	Turbidity	58
	5.5.1 Measurement Principle	58
	5.5.2 Ambient Light	58
	5.5.3 Light Source Variation	58
5.6	The DS3 Multiprobe's RS-232 Communication Mode	59
5.7	Performance Measurement and Improvement	60

PART SIX: TROUBLESHOOTING61

- Multiprobe will not start printing:61
- Data is printed without header information:61
- Only one data line is printed:61
- Typed command is not accepted; functions cease:61
- "Out of tolerance, calibration is not saved!" message printed:62
- Dissolved Oxygen readings are too low to calibrate,
and/or pH and/or Redox readings are very high or very low:62
- Conductivity, Temperature, and/or Depth readings seem wrong62
- Dissolved Oxygen readings seem wrong63
- Has water leaked into your multiprobe?63

PART SEVEN: LOGGING65

- 7.1 Parts of the Logging System65
- 7.2 The Logging Menu65
- 7.3 Dumping (Recovering) Data from the Memory65
 - 7.3.1 Getting Started65
 - 7.3.2 If You are Dumping as Printer Ready68
 - 7.3.3 If You are Dumping as Spreadsheet Importable69
- 7.4 Erasing Files70
- 7.5 Setting Up a Logging Run71
- 7.6 Status72
- 7.7 Review74
- 7.8 Store75
- 7.9 Annotate75
- 7.10 Deployment75
- 7.11 Autolog75
- 7.12 Power Supplies for Logging76
- 7.13 Changing the Batteries in the Internal Battery Pack76
- 7.14 Changing Batteries in the Submersible Battery Pack77
- 7.15 Memory and Battery Limitations to Logging Runs78
- 7.16 Multiprobe Warm-Up79

APPENDICES

APPENDIX 1

Dissolved Oxygen

A1.1 DO Saturation Values

A1.2 LoFlow™ and Standard Membranes

APPENDIX 2

Performance Manual for Field Water Quality Instrumentation

APPENDIX 3

Application Notes

AN#101 Dissolved Oxygen Sensor Life

AN#102 pH Measurement

AN#103 Instructions on PROCOMM® PLUS Communication Program

AN#104 Underwater Cable Handling

AN#105 Comparison of 3 Dissolved Oxygen Measurement Methods

AN#106 Battery Life

AN#107 Securing Multiprobes to a Structure

AN#108 Troubleshooting Dissolved Oxygen

AN#109 Parameter Specifications for Hydrolab Multiprobes

APPENDIX 4

Technical Data

A4.1 DataSonde 3 Cable Pinouts

A4.1.1 RS-232 (with 9D) Pinout

A4.1.2 RS-232 (with 25D) Pinout

A4.1.3 SDI Pinout

A4.2 DataSonde 3 Connectors

A4.3 DataSonde 3 Currents

APPENDIX 5

Using the DataSonde 3 /SDI Interface

ADDITIONAL INFORMATION

- Hydrolab Instrument Ordering Guide
(including Service & Limited 2-Year Warranty)
- Service Memorandum (quantity 3)



PART ONE

INTRODUCTION

1.1 Components and Assembly

Use Figure 1.1 to identify the terminal, multiprobe, battery, underwater cable, calibration and interface cables, and other parts of the DataSonde 3 Multiprobe system.

Attach the underwater cable to the multiprobe. Note the connector's keying; don't force the pins into the wrong part of the underwater cable's connector. Connect the interface cable to the underwater cable; it will only fit one way.

Next, connect the other end of the interface cable to the serial port of your terminal. If you are unsure of this connection, please refer to the wiring charts at the end of the manual.

WARNING: CONNECTION OF HYDROLAB INSTRUMENTATION TO ANY POWER SOURCE THAT IS IN ANY WAY CONNECTED TO A VOLTAGE SOURCE RATED OVER 18 VOLTS CAN RESULT IN ELECTROCUTION THAT CAN KILL YOU. DO NOT USE A TRANSFORMER THAT PLUGS INTO THE WALL TO PRODUCE A LOW-VOLTAGE SUPPLY. USE ONLY BATTERIES WHOSE TOTAL VOLTAGE IS UNDER 18 VOLTS DC.

Third, turn on your terminal and, if your terminal is a computer, boot a communications program (such as Procomm Plus[®] for the IBM[®] PC compatibles, or MacTerminal[®] for the Apple[®] Macintosh[®]). To get started, set the terminal to 1200 baud, eight bit, no parity, one stop bit.

Now, connect the remaining connector of the interface cable to the battery. You can use Hydrolab's rechargeable 12-volt gel cell, or any other 12-volt battery. The latter will require an auxiliary battery cable; be sure to observe the polarity markings (red terminal is positive, black terminal is negative or ground).

At this point, the multiprobe will begin sending data to the terminal. If not, check your battery's voltage (it must be between about 9 and 18 volts), or refer to PART SIX: TROUBLESHOOTING.

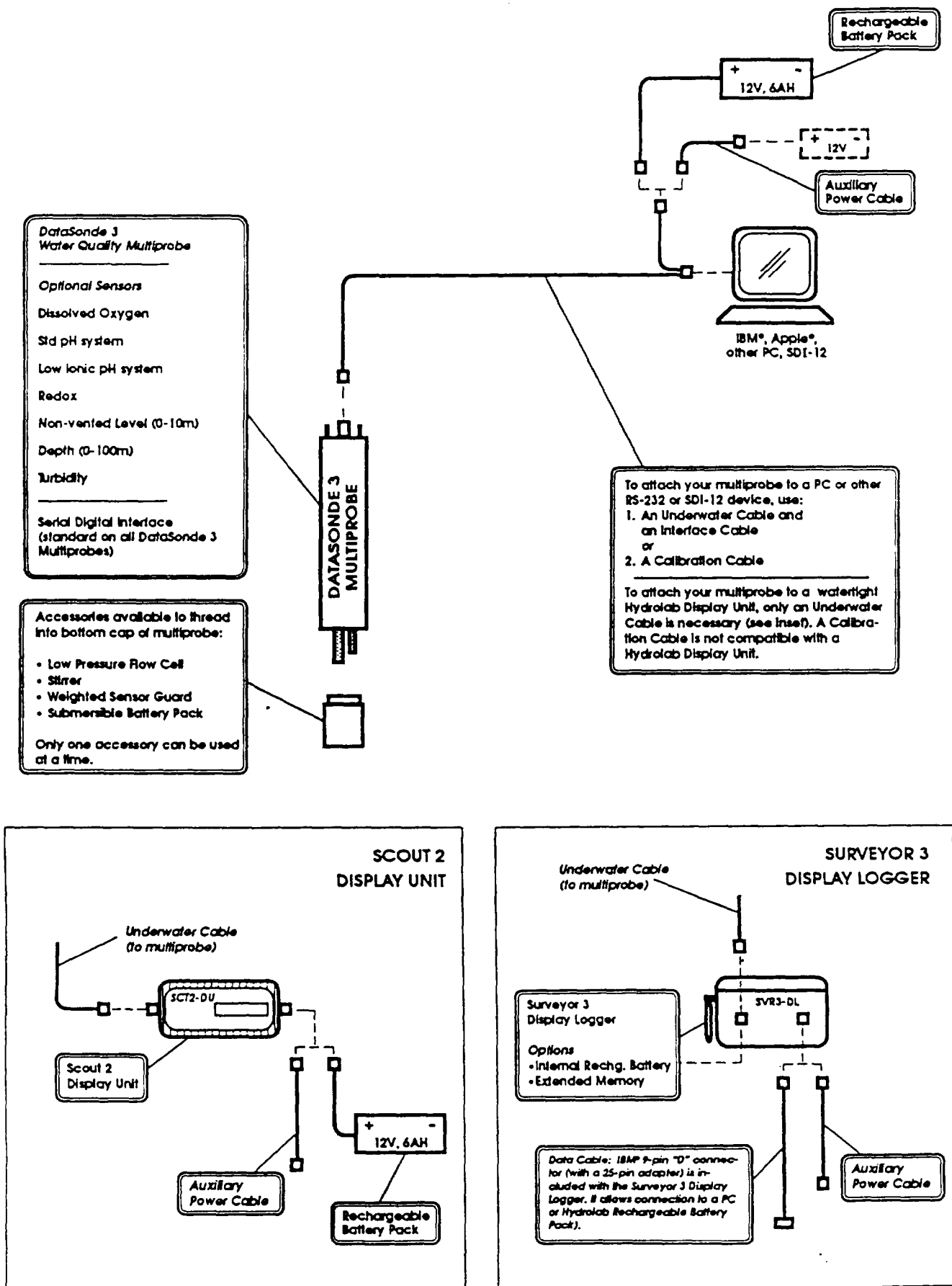


Figure 1.1 DataSonde 3 System Components

The first information you see printed is the multiprobe's software version, plus the multiprobe's identification label:

Hydrolab DataSonde 3 X.YZ
(C)opyright 1990 Hydrolab Corporation
ABCDEFGHIJKL

On the next rows are printed the parameters and their units that identify the data columns that follow:

Time	Temp	pH	SpCond	Salin	DO	DO	Redox	Depth	Batt
HHMMSS	deg C	units	mS/cm	ppt	% Sat	mg/l	mV	meters	volts
145852	25.00	10.02	1.00	10.0	84.3	6.94	-17	0.2	13.2

The header you see may be slightly different. For instance, if your multiprobe was preset to measure total dissolved solids instead of salinity, you would see TDS Kmg/l instead of Salin ppt. Plus, some of the parameters may have been disabled, so that their headings are not printed at all. And, some of the readings may have one or more symbols printed nearby (don't worry, we'll talk about those in Section 2.13). Note: the readings you see are measurements of the water in the Storage Cup.

It is also possible that after turning the terminal on, you will get, after a 5-second pause, lines of data without any header information. This means that the previous operator disabled the header function so that only uninterrupted data is sent to the terminal. See Section 2.6.9 for more information. Again, if only one line of data is printed, please refer to Section 2.5.9 for explanation.

After the header is displayed, data from the multiprobe is automatically displayed, row after row, until the operator causes printing to cease. The automatic sending of rows of data is called the Standard Operating Mode (SOM) for the DS3 Multiprobe. If, after turning the multiprobe on, you get only one line of data, please refer to Section 2.5.9.

1.2 Introductory Exercise

Suppose that we wish to reset the time reading. If you hit the terminal keyboard's space bar during the SOM, you will get the Basic Menu:

Hydrolab DataSonde 3 VX.YZ

(P)arameters,
(C)alibrate,
(V)ariables,
(L)ogging,
(H)eader,
(M)easure,
(I)dentify,
or (Escape or Ctrl X To cancel)
Select:

(By the way, you do not have to hit the return key when you type in a response to any of the multiprobe's menus; the multiprobe will finish the word and the return for you. However, you must hit the return key after answering questions requiring multicharacter inputs. This is because the multiprobe always expects only a single letter for menus, but cannot know how many numbers you are going to type for an answer requiring multicharacter input. Also, you can edit multicharacter answers by typing a control-H or, on some machines, a backspace. If an invalid character is typed as a menu response, a bell will sound and you will be given another chance.)

If you see a lot of letters not in the Basic Menu form shown above, type a V and then an X and then a D to get you out of the Expert, or shorthand, menu format. Now, you will see the Basic Menu with all the words spelled out, as above. Type a C to get into the Calibrate menu:

(p)H,
Specific (C)onductance/Resistivity,
(S)alinity/TDS,
(%) Sat,
D(O),
(R)edox,
(D)epth/Level,
(L)abel,
(T)ime,
(I)nterval,
(M)essage,
or (Escape or Ctrl X to cancel)
Select:

Type in a T to get:

Enter Date (MMDDYY):

If the current date is February 21, 1989, you would type in 022189. Hit the return key to fix the date. Next you will see:

Enter Time (HHMMSS):

If the current time is 19 seconds past 2:38 PM, you would now type in 143819. If the time is exactly 9:18 AM, you would type in 091800. After you have typed in the sixth digit, hit the return key to set the time. The regular listing of parameter data (SOM) will resume.

Suppose that you now wish to calibrate specific conductance. Fill the calibration cup with a prepared standard for which the specific conductance is known, for example, to be 1.413 millimhos/cm. (See PART THREE: MAINTENANCE and CALIBRATION for more details on calibration.) When the specific conductance readings have stabilized for this new solution (this might require one or two minutes), press the terminal's space bar to get from the SOM to the Basic Menu. Again, type in a C to get to the Calibrate menu, but this time type a C to allow calibration of Specific conductance/Resistivity:

Enter Specific Conductance (mS/cm):

If you are sure that the specific conductance reading had stabilized before you started this calibration routine, type in 1.413 (the standard's value in millimhos/cm; remember that a control-H or backspace can be used for editing mistakes when typing in numbers) and hit the terminal's return key. The calibration is automatically set, and the multiprobe will revert to the SOM. Notice that the specific conductance reading is now 1.413: the calibration point. (If you should hear a bell and get the message "Out of tolerance, calibration is not saved!", please see Section 2.5.)

Next, suppose that you were using a computer as your terminal and you were having it store the readings on disk. But, to preserve memory space, you wished only to store temperature, specific conductance, and time.

Hit the space bar to go from the SOM to the Basic Menu:

Hydrolab DataSonde 3 VX.YZ

(P)arameters,

(C)alibrate,

(V)ariables,

(L)ogging,

(H)eader,

(M)easure,

(I)dentify,

or (Escape or Ctrl X to cancel)

Select:

Type a P (for Parameters) to get:

(p)H,

Specific (C)onductance/Resistivity,

(S)alinity/TDS,

(%) Sat,

D(O),

(R)edox,

(D)epth/Level,

(B)attery,

(A)ll,

or (Escape or Ctrl X to cancel)

Select:

Type an R if you wish to consider Redox:

(E)nable,

(D)isable,

or (Escape or Ctrl X to cancel)

Select:

Now type a D to Disable Redox (that is, remove it from the set of parameters being printed). You will be returned automatically to the SOM; access "Parameters" again from the Basic Menu to remove more parameters until only temperature, specific conductance, and time remain:

Time	Temp	Cond
HHMMSS	deg C	mS/cm
145852	25.12	1.420

Notice that temperature and time cannot be disabled. See Section 2.4 for more details. Of course, you can reverse the procedure by typing an E to Enable parameters that have been disabled.

Press the PC's space bar to get the Basic Menu, then press L (for Logging) and then S (for Store) to save the current data to the Manual file. Repeat to add more data to the Manual file.

Now press the PC's space bar to get the Basic Menu, then press L (for Logging) and then D (for Dump) to get:

Power down probe during dump?
(Y)es,
(N)o,
or (Escape or Control X to Cancel)
Select:

Type Y if you want to cut power to the probes during the data dump; it will save battery power. Type N, otherwise, to get:

###	Log File Name		Start MMDDYY HHMMSS	Stop MMDDYY HHMMSS	Interval HHMMSS
0	=>AUTOLOG<=	<=Enabled	010100 000000	123199 235959	010000
1					
2					
3					
4					
5	=>MANUAL<=		010100 000000	010100 000000	000000

(The above output varies with user input.) Type a 5 and Return from the PC's keyboard to select the Manual file, since data entered with Store is always stored in the Manual file. You will then see:

(P)rinter ready,
(S)preadsheet importable,
or (Escape or Control X to Cancel)
Select:

Type an S and Return to get:

(S)etup Variables and Calibration,
(F)ollow Variables and Calibration,
(C)urrent Variables and Calibration,
or (Escape or Control X to Cancel)
Select:

This allows you to dump the file according to several calibration scenarios. Typing S means the data printed will be based on the calibration (and Variables settings) in effect at the time the logging run was set up. An F means that the data is based on the calibration (and Variables settings) in effect at the time the actual measurements were made. A C means the data is dumped based on the calibration (and Variables settings) as it is set now.

Because we are dumping a manual file, we probably want to see the data as it was taken, so type F and Return to get:

Starting XMODEM Transfer ...

You must now tell your communications program to proceed with a X-modem download. (If you are using Procomm, hit the "page down" key and select Option 1.) Then, when asked, type in, with the PC's keyboard, the name you wish to give the file containing your field data (say, TWINLAKE.DAT) and press Return. You will shortly see:

Transfer completed!

You can now close your communications program, open a spreadsheet, and then import the TWINLAKE.DAT file into the spreadsheet. You will see all of your data, with the time they were taken.

1.3 Important Note

Although you have now performed most of the basic operations available on the DataSonde 3 Multiprobe, please read PART TWO: MENUS to discover the multiprobe's other features. Also, be sure to read PART THREE: MAINTENANCE and CALIBRATION, since only a well-maintained and carefully-calibrated instrument will provide quality data. The remainder of this manual, although primarily reference material, should be read, too.

1.4 The Performance Manual

You will find at the end of this manual, Appendix 2, which is Hydrolab's "Performance Manual for Field Water-Quality Instrumentation". This article contains many helpful hints for both qualifying and improving the reliability of your data. You might be surprised to find out what your Hydrolab instrument can really do.



PART TWO: DATA DISPLAY & MENUS

2.1 Data Display

Once you have established communication between the multiprobe and your terminal (Section 1.1), the system will automatically print the introductory heading:

```
HYDROLAB DataSonde 3 V X.YZ  
(C)opyright 1990 Hydrolab Corporation  
ABCDEF123456
```

Time	Temp	pH	SpCond	Salin	DO	DO	Redox	Depth	Batt
HHMMSS	deg C	units	mS/cm	ppt	% Sat	mg/l	mV	meters	volts

If no header information is printed (and you want to see the header information), you can re-enable the header function. See Section 2.6.9.

The first line tells you your multiprobe's software version (as in Version 2.00, for instance); the second line is the multiprobe's up-to-12-character alpha-numeric name (which you can change at any time). The third line identifies the columns by parameter. Specific Conductance/ Resistivity, Salinity/TDS, Dissolved Oxygen, and Battery are abbreviated. Redox is the same as oxidation-reduction potential, ORP, and Eh.

The fourth line identifies the units of measurement for each parameter. The units abbreviated are hours-hours minutes-minutes seconds-seconds (Time-measurement format), degrees Centigrade, milliSiemens per centimeter (same as millimhos per centimeter), parts per thousand, percent saturation, milligrams per liter (same as parts per million), and millivolts.

Immediately following the printing of the header, the multiprobe will adopt its standard operating mode (SOM): printing row after row of parameter readings. The third and fourth lines of the introductory header will be reprinted once every 24 lines so that you can identify the columns after the initial header has scrolled off the computer's screen. This also guarantees that any data printed on standard-sized paper will have parameter identification on each page.

If any of the parameter values in the printout are accompanied by an asterisk (*), that parameter value is based on a default calibration setting. This means that the parameter was never calibrated. Note that some calibrations affect more than one parameter. For instance, uncalibrated specific conductance will cause an asterisk annotation on the specific conductance, resistivity, salinity, total dissolved solids, dissolved oxygen (ppm, but not % saturation), and depth or level readings. This is because specific conductance data is used

to calculate or correct the latter five parameters. Other symbols near the parameter readings are explained in Section 2.13.

2.2 The Menu Hierarchy

Figure 2.1 shows the menu structure for the DS3 Multiprobe. Remember that pressing the space bar while the multiprobe is in the SOM will produce the Basic Menu.

2.3 The Basic Menu

The multiprobe will stay in the SOM until you make it quit by unplugging it from the power supply or the terminal, or by accessing the Basic Menu. The latter is accomplished by pressing the terminal's space bar while in the SOM. Data printing will stop and the following message, the Basic Menu, will appear:

HYDROLAB DataSonde 3 V X.YZ

(P)arameters,

(C)alibrate,

(V)ariables,

(L)ogging,

(H)eader,

(M)easure,

(I)dentify,

or (Escape or Ctrl X to cancel)

Select:

At this point, typing the proper letter (i.e., the letter in parentheses) will access the menu entry of interest. For instance, typing a C will access the Calibrate menu.

Important: If you change your mind about accessing the Basic Menu, or any other menu routine, just press your terminal's Escape or control key and the X key at the same time. The menu will disappear and the operation will revert to the SOM. On the Macintosh, the control key is the Command key: the little four-leaf-clover-looking figure key right next to the Option key and just left of the space bar.

See
ADDENDUM F
in the front of this manual
for latest version.

2.4 Parameters

Typing a P from the Basic Menu will give you the message:

(p)H,
Specific (C)onductance/Resistivity,
(S)alinity/TDS,
(%) Sat,
D(O),
(R)edox,
(D)epth/Level,
(B)attery,
(A)ll,
or (Escape or Ctrl X to cancel)
Select:

Suppose you wish to add Depth to the set of parameters being printed in the SOM. You would type a D to get:

(E)nable,
(D)isable,
or (Escape or Ctrl X to cancel)
Select:

Now type an E to Enable the parameter you have already selected, Depth. You will be returned automatically to the SOM; you will now see Depth measurements being printed. Other parameters can be added in the same fashion.

Obviously, if you wish to remove one or more parameters to the data being displayed, you would access Parameters from the Basic Menu, select the parameter of interest, and then type a D for Disable. Time and Temperature cannot be disabled.

Usually, you can add or remove parameters only one at a time; you must re-access Enable or Disable of the Parameter menu to remove others. However, if you are making a lot of changes, it might be easier to type an A from the Parameters menu, and then an E or a D to Enable or Disable All parameters (except Time and Temperature).

Some parameters must be printed as sets; e.g. you cannot measure salinity-corrected DO (ppm) without measuring some form of specific conductance (specific conductance, salinity, resistivity, or TDS). So, disabling all

forms of specific conductance will automatically disable DO (ppm) if you had already specified that you want your DO (ppm) readings corrected for salinity. Conversely, if you enable DO (ppm), specific conductance will be enabled automatically.

2.5 Calibrate

If you type a C while in the Basic Menu, you will access the Calibrate function and so will get this message:

```
(p)H,  
Specific (C)onductance/Resistivity,  
(S)alinity/TDS,  
(%) Sat,  
D(O),  
(R)edox,  
(D)epth/Level,  
(L)abel,  
(T)ime,  
(I)nterval,  
(M)essage,  
or (Escape or Ctrl X to cancel)  
Select:
```

Now, for instance, typing an S will allow you to Calibrate Salinity/TDS.

Notice that Temperature and Battery are not calibratable, since they are permanently set at the factory. The two Dissolved Oxygen functions DO (mg/L concentration) and % Saturation need not (actually, cannot) be calibrated independently. Instead, you would choose % Saturation if you wanted to calibrate to atmospheric conditions (i.e., the traditional "air cal"), in which case the DS3 would calculate the actual calibration value. You would choose DO if you wanted to be able to input a special calibration value (for instance, a Winkler titration value) that is different from the value that would be calculated by the DS3 (based theoretically on ambient temperature and barometric pressure).

Also, you can directly calibrate either Specific Conductance/ Resistivity or Salinity/TDS, but not both independently (they are both measured with the same sensor). If you have calibrated Specific Conductance/ Resistivity, and then you calibrate Salinity/TDS, then the calibration of Salinity/

TDS will be translated into a Specific Conductance/ Resistivity calibration, and the original Specific Conductance/ Resistivity calibration will be lost.

You might notice that the DS3 Multiprobe has built-in checks for calibration acceptability. If the calibration value you enter is too far out of bounds, a bell will sound and the message "Out of tolerance, calibration is not saved!" will appear. You will be returned to the SOM. You should verify your calibration standard value and/or check the condition of the sensor to determine why the calibration was not acceptable. See PART THREE: MAINTENANCE and CALIBRATION for more help.

2.5.1 pH

Typing P will result in:

Enter pH (units):

Always calibrate with 7-buffer (the pH system's zero) before calibrating with a second buffer (the pH system's slope). If your readings for 7-buffer had stabilized in the SOM, you would now type in the value of your buffer to automatically calibrate the pH system zero. The multiprobe will accept any pH value between 6.8 and 7.2 for the zero setting. At this point, you would be returned to the SOM so that you could begin monitoring pH readings for the second, slope-setting buffer, if you so choose. Once those readings stabilize, you would again access the Basic Menu, then the Calibrate menu, then the pH menu to get:

Enter pH (units):

again. So type in the value of your slope buffer (such as 9.18 or 4.02 pH units) and hit the return key. (Your slope buffer value cannot fall between 6.8 and 7.2; the multiprobe recognizes that range as the zero calibration.) The slope will be set and you will be returned to the SOM.

2.5.2 Specific Conductance/Resistivity

If you wish to calibrate Specific Conductance, you would monitor those readings in the SOM until they had stabilized for whatever standard solution in which you have immersed the sensor. Typing C from the Calibrate menu will result in this message:

Enter Specific Conductance (mS/cm):

So, type in the calibration standard's value in milliSiemens/cm (same as millimhos/cm). For instance, one millimolar KCl (value of 147 micro-Siemens/cm) would be typed in as 0.147. Hit the return key to set the calibration and return to the SOM.

Had you decided to measure Specific Conductance's alternative, Resistivity, by choosing Resistivity over Specific Conductance in the Variables menu (Section 2.6.2), selecting C from the Calibrate menu would have gotten you this:

Enter Resistivity (K ohms/cm):

You would then type in your calibration standard's value in the proper units for Resistivity instead of Specific Conductance.

2.5.3 Salinity/TDS

If you wish to calibrate Salinity, you would type an S from the Calibrate menu to get:

Enter Salinity (ppt):

Now type in the value of your Salinity standard, in parts per thousand at 25°C, and hit the return key. You will be returned to the SOM as the new calibration is set.

Just like Specific Conductance/Resistivity, you can measure Salinity or TDS (total dissolved solids), but not both (see Section 2.6.2). If you are measuring and reading TDS, you would have been asked to:

Enter TDS (k mg/l):

If your calibration standard was 21.9 mg/l TDS, then you would have typed in 0.0219, followed by a carriage return. Notice the standard must be entered in k mg/l (that is, grams/liter).

Remember that you can calibrate either Specific Conductance/ Resistivity or Salinity/TDS, but not both independently.

2.5.4 Dissolved Oxygen

After setting up the dissolved oxygen (DO) sensor as required for calibration (detailed in PART THREE: MAINTENANCE and CALIBRATION) and waiting for a stable reading, type % from the Calibrate menu to get:

Enter Barometric Pressure (mmHg):

You must type in the local barometric pressure in millimeters of mercury (for instance, 760 at sea level). Check your barometer or weather bureau for this information (and see Section 5.3). The calibration for both DO mg/l and DO % Saturation will be set once you press the return key, and you will be returned to the SOM. Check the calibration by looking at the DO % Saturation reading; it should be 100.0 for the Standard Membrane, or 102.5 for the Hydrolab LoFlow™ Membrane (see Section 3.7). Please read Appendix 1 to see how this number correlates to DO concentration.

Alternatively, you would press O (O, not zero) instead of % to get:

Enter Barometric Pressure (mm Hg):

Type in the local barometric pressure (as above) and press the return key to get:

Enter DO (mg/l):

Now type in the DO concentration of the calibration standard as you have measured it (with a Winkler titration, other instrumentation, etc.). Press the return key to set the calibration and return to the SOM.

2.5.5 Redox

Typing an R will produce the message:

Enter Redox (mV):

You must now type in the value of your Redox (aka, ORP or Eh) standard, followed by a carriage return. You will be returned to the SOM. Be extra sure with Redox that a stable reading for the standard solution was reached before calibration was made; Redox readings are inherently slow to equilibrate.

2.5.6 Depth/Level

Depth can be simply zeroed in air, at or near the surface of the water to be sampled. Otherwise, it can be set at some known depth in the water column. Once the multiprobe is a position for which the depth is known, type D from the calibrate menu to get:

Enter Depth (meters):

If you are reading depth in feet (Section 2.6.5), you would be asked for feet instead of meters. Type in the calibration depth in the called-for units, and hit the return key to get back to the SOM.

2.5.7 Label

Typing L (for Label) will allow you to change the multiprobe's name (that is printed under the multiprobe's software version number in the opening header):

Enter Label:

Type in as many as 12 characters (alpha, numeric, or spaces, and then return) to give the multiprobe a name that you can use for identification. You will be returned to the SOM.

2.5.8 Time

If you type a T while in the Calibrate Menu, you access the Time functions and get this message:

Enter Date (MMDDYY):

Now type in the correct date in the month-month day-day year-year format. For instance, July 4, 1776 is 070476. Upon hitting the return key, you will get the opportunity to set or correct the time:

Enter Time (HHMMSS):

You must now type in a new real-time setting to replace the time currently displayed in the first column of the SOM printout. Generally, the time must be reset only if you want to make it read just what your watch is reading. Type in the correct time in the military HHMMSS (Hour-Hour

Minute-Minute Second-Second) format: if it is exactly 5:30 in the morning, you would type 053000. If it is 25 seconds past 10:18 PM, you would type 221825. Obviously, numbers greater than 59 cannot be typed into the minutes or seconds positions, and numbers greater than 23 cannot be typed into the hours position. 000000 is the designation for midnight. Once you have typed exactly six digits, hit the Terminal's return key and you will be returned to the SOM that now includes the corrected time (and date) readings.

2.5.9 Interval

Had you typed an I (for Interval) out of the Calibrate menu, you would have received the message:

Enter Interval (HHMMSS):

However, instead of being asked to set the correct time, you are now required to specify the interval between lines of data. If you wished to have a new line of data printed every 10 seconds, you would type 000010; if you wished a new line only every hour and a half, you would type 013000. Hit the return key after having typed exactly six digits and you will be returned to the SOM. The multiprobe remembers this number even after it is unplugged, so that the next time you establish communication between the multiprobe and the terminal, the data will be printed at the frequency last specified by the operator.

Note that numbers greater than 59 cannot be typed into the number positions for either seconds or minutes. For example, if you want to see readings every 90 seconds, you must type in 000130, not 000090. Similarly, a number greater than 23 cannot be entered in the hours position.

The maximum interval time allowable is 24 hours (designated 000000). The minimum interval is one second (000001), but there is a possibility that your terminal cannot print a whole line of data every second (if you are working at 300 baud). In this case, you should change the interval or disable some of the parameters (Section 2.4). A three-second interval allows all parameters to be printed at 300 baud. All other supported baud rates can print a full line of data every second.

After turning the multiprobe on, you may get the header but only one line of data. This might be caused by a very long interval setting. Hit the space bar (to get into the Basic Menu), type T, and then type I, so that you can enter a shorter interval time, if desired.

2.5.10 Message

If you are working with a computer that is saving everything you do to disk memory, or if your work is being printed on paper continuously, the Message feature allows you to insert notes into the record being created. For instance, if you adjusted the pH in a tank, you might access the Calibrate menu, type an M for Message, to get:

Message:

You can now type in up to 79 characters of message, followed by a carriage return. Your output might look like this:

Time HHMMSS	Temp deg F	pH units	Cond mS/cm	DO mg/l
101600	25.77	5.65	0.583	7.96
101700	25.78	5.66	0.583	7.94
101800	25.78	5.65	0.583	7.95
101900	24.31	7.08	0.670	7.18
I just dumped 16 oz. 0.01N sodium bicarbonate in Shrimp Tank #4.				
102000	24.40	7.12	0.655	6.97

and so on (for clarity, some menu items have been edited from the above example; you can do the same kind of clean-up with your word processor). The reason for the sudden shift in pH readings is now in the permanent record.

2.6 Variables

The V of the Basic Menu stands for Variables; accessing this menu by typing a V from the Basic Menu allows you to specify a number of measurement and operational criteria. These Variables will be remembered by the multiprobe even after the multiprobe has been turned off (that is, there is no need to reset the variables each time the multiprobe is turned on). The Variable menu is:

(T)emperature,
Specific (C)onductance/Resistivity,
(%) Sat,
D(O),
(D)epth/Level,
(A)utolog,
SDI-12 Addr(e)ss,
SDI-12 De(l)ay,
(H)eadler,
(B)uzzer,
(S)tirrer,
E(x)port,
Ba(u)d Rate,
(R)eport,
or (Escape or Ctrl X to cancel)
Select:

Typing any of the parenthetical letters will select that feature for setting of operational Variables.

2.6.1 Temperature

Typing a T from the Variable menu will produce this:

(C)entigrade,
(F)ahrenheit,
or (Escape or Ctrl X to cancel)
Select:

Type a C if you want the temperature readings to be in degrees Centigrade; type an F if you want them in degrees Fahrenheit. Either way, you will be returned to the SOM.

2.6.2 Specific Conductance/Resistivity

Typing a C from the variable menu results in:

Specific (C)onductance,
(R)esistivity,
or (Escape or Ctrl X to cancel)
Select:

Type a C if you wish to measure and print Specific Conductance instead of Resistivity. Type an R, otherwise, or press an Escape or Control X to return to the SOM. If you typed a C or an R, you would continue through this section of the Variables menu with this request:

(m)S/cm,
(u)S/cm,
or (Escape or Ctrl X to cancel)
Select:

Type an m if you want your data reported in milliSiemens/cm, or a u if you need microSiemens/cm. You would then see:

(F)resh,
(S)alt,
or (Escape or Ctrl X to cancel)
Select:

Type an F if your multiprobe is equipped with a Freshwater cell block, or type an S if it has a Seawater cell block (see Section 3.4), or press an Escape or Control X to return to the SOM. If you typed an F or an S, you would continue through this section of the Variables menu with this request:

(A)uto range,
(H)igh range,
(M)edium range,
(L)ow range,
or (Escape or Ctrl X to cancel)
Select:

Typing an A will allow the DS3 to automatically select the appropriate Specific Conductance-measuring range. Typing an H will mean that all your readings will be made in the High (0 to 100 mS/cm) range (you will lose resolution in the lower readings), and so on. This feature allows users of data collection platforms and certain types of data recorders to compress data into a more efficient format. The next item in the menu is:

(S)alinity,
(T)DS,
or (Escape or Ctrl X to cancel)
Select:

Type an S if you wish to measure and print Salinity instead of TDS. Type a T, otherwise, or press an Escape or Control X to return to the SOM. If you typed an S or T, you would continue through this section of the Variables menu:

(T)emperature compensated,
(U)ncompensated,
or (Escape or Ctrl X to cancel)
Select:

Type a U if you want you Specific Conductance/Resistivity and Salinity/TDS readings to be reported without reference to 25°C, that is, raw. Type a T, otherwise, or press an Escape or Control X. Since this is the end of the Specific Conductance/Resistivity section of the Variables menu, you will be returned to the SOM no matter which selection you type.

2.6.3 % Sat

Typing a % from the variable menu will get you:

Enter Barometric pressure (mmHg):

This allows you to enter a local barometric pressure different from that of calibration, if necessary, so that the % Saturation readings can be corrected accordingly. The DO concentration measurement (mg/l) does not require this type of correction.

2.6.4 DO

Typing an O from the Variables menu will let you specify a few things about your DO measurements:

(S)tandard,
(L)oFlow,
or (Escape or Ctrl X to cancel)
Select:

Type an S if you are using a Standard Membrane, or type an L if you are using a LoFlow membrane and its helper software (see Section 3.7 or Appendix 1 for more explanation). As usual, pressing an Escape or Control X will

abort the routine and send you back to the SOM. If you typed S or L, you will be asked:

(S)alinity compensated,
(U)ncompensated,
or (Escape or Ctrl X to cancel)
Select:

Type an S if you want your DO (mg/l) readings to be compensated for the effect of sample salinity. Type a U, otherwise, or press an Escape or Control X. You will be returned to the SOM.

2.6.5 Depth/Level

Typing D from the Variable menu will produce:

(M)eters,
(F)eeet,
or (Escape or Ctrl X to cancel)
Select:

Type M if you want the depth or level data to be printed in meters, or F if you work in feet. You will then get:

(D)epth,
(L)evel,
or (Escape or Ctrl X to cancel)
Select:

Type a D if your multiprobe is equipped with a Depth transducer (having a range of 0 to 100 meters). Type an L if your multiprobe is equipped with a Level transducer (having a range of 0 to 10 meters). (The transducer type is printed on the multiprobe's label.) You will be returned to the SOM.

2.6.6 Autolog

Typing an A from the Variable menu will access Autolog. At this time, you will get the message:

(E)nable,
(D)isable,
or (Escape or Ctrl X to cancel)
Select:

Autolog is the automatically-started logging sequence that provides a backup to your logging routines. If you set up a multiprobe for logging, but made a set-up error (such as the wrong starting time). If you had taken the precaution of enabling Autolog at the same time as the logging setup, that function would be gathering your data continuously, at one-hour intervals (all parameters are automatically enabled, as are Stirrer, Buzzer, and Warmup). When you retrieved the multiprobe from the field, you would find data collected by Autolog, since the normal logging run was not correctly activated. See Section 7.8 for more information.

2.6.7 SDI-12 Address

Typing an E from the Variable menu will produce:

Enter SDI-12 Address (0-9):

You would type in the SDI-12 address that you wish to assign to this DS3.

2.6.8 SDI-12 Delay

Typing an L from the Variables menu shows:

Enter SDI-12 Delay (seconds) (5-994):

You would type in the SDI-12 measurement delay desired for this DS3 (normally, 30 or 120 seconds).

2.6.9 Header

Typing H from the Variable menu will produce:

(E)nable,
(D)isable,
or (Escape or Ctrl X to cancel)
Select:

Type E if you want the header information to be included with the data lines; type D if you do not. The header information is the software version number, copyright notice and the multiprobe's identification label (both printed only once as the multiprobe is turned on), and the line of parameter identifiers that is reprinted every 24 lines.

2.6.10 Buzzer

Typing B from the Variables menu will get you:

(E)nable,
(D)isable,
or (Escape or Ctrl X to disable)
Select:

Type an E to cause the Buzzer to beep each time a set of readings is made. While the Buzzer will sound for each data measurement cycle made by the DS3, it is especially helpful when checking to make sure a logging sequence has begun on time. For instance, if you have to start making measurements in a stream at noon, set the logging sequence to start at 113000. Before the multiprobe is deployed, you can wait for that first beep at either 112800 or 112930 (depending on whether you have set the DS3 for a 30-second or 2-minute warmup) to assure you that the logger is working. The multiprobe can then be confidently deployed with plenty of equilibration time before the noon readings.

2.6.11 Stirrer

Typing S from the Variables menu will produce:

(E)nable,
(D)isable,
or (Escape or Ctrl X to cancel)
Select:

Type an E to allow power from the multiprobe to be sent to the Stirrer, if your work requires the use of a Stirrer. Otherwise, type a D. This function allows the multiprobe to automatically turn on the Stirrer for logging runs, if the Stirrer operation is desired.

2.6.12 Expert

Typing an X from the Variables menu will produce:

(E)nable,
(D)isable,
or (Escape or Ctrl X to cancel)
Select:

Type an E to enable the Expert menu format; type a D to disable Expert. All this does is use abbreviations for most of the regular menu items. Using Expert lets you save paper, if you are printing your work, and lets you view more information on the screen. For instance, if you are not in the Expert menu mode and you select Variables from the Basic Menu, the Variables menu takes up 26 lines of paper or screen. If Expert is enabled, you would see this 2-line prompt instead:

```
PCVLHMI: Variables
TC%ODAEHBSXUR:_
```

You would select from this the same letters as you would from the fully spelled-out, 14-line Variables menu; the selections are just abbreviated. The cursor ending the last line indicates that the DS3 awaits a selection.

If you find the Expert menus confusing, type an Escape or Control X to get to the SOM, and then hit the Space Bar, type a V, type an X, and type a D. This disables Expert and returns you to the SOM.

2.6.13 Baud Rate

The only time that 1200 baud is not fast enough to keep up with a DS3 is during recovery of logged data. Baud Rate allows you to set the DS3 to a different baud rate before you dump a memory file.

Type U from the Variables menu to access the five available baud rates; type a 9, 4, 2, 1, or 3 to get the baud rate you want. The DS3 now prints:

Change to new baud rate, press any key ...

You must then access your communications program (like Procomm Plus) and change your computer (or other peripheral) over to the selected baud rate. Otherwise, your DS3 and computer will be running different baud rates and will not communicate. At power up, DS3 always starts at 1200 baud.

2.6.14 Report

There are dozens of different combinations of Variable settings, and some operators might require different settings for different multiprobes. To recall what Variables have been set for a specific multiprobe, type an R from the Variables menu to get a Report:

Temperature: Centigrade
Specific Conductance/Resistivity: Resistivity, mS/cm, Fresh, Auto range,
Salinity, Temperature compensated
% Sat: 760
DO: Standard, Salinity compensated
Depth/Level: Meters, Level
Autolog: Enable
SDI-12 Address: 0
SDI-12 Delay: 30
Header: Enable
Buzzer: Enable
Stirrer: Enable
Expert: Disable
Baud Rate: 1200

Press any key to continue ...

This example Report indicates a multiprobe set up to read Temperature in degrees Centigrade, temperature-compensated Resistivity and Salinity in mS/cm with a Fresh water cell block, auto range readings, salinity-compensated DO with a Clark-type cell, and Level in meters, % Sat barometric pressure is 760 mmHg, SDI-12 address set to zero, SDI-12 delay set to 30 seconds, Autolog working, the Header being printed, and the Buzzer beeping for each set of readings. And, the Stirrer is running and the menu items are being spelled out fully. We are operating at 1200 baud. You will be returned to the SOM after pressing any key.

2.7 Logging

If you type an L from the Basic Menu, you will be able to set up a logging routine for automatic, unattended monitoring. Please see PART SEVEN: LOGGING for complete information.

2.8 Header

If you type an H from the Basic Menu, you will cause your Header to be printed immediately, for example:

ABCDEF123456

Time	Temp	pH	SpCond	Salin	DO	DO	Redox	Depth	Batt
HHMMSS	deg C	units	mS/cm	ppt	% Sat	mg/l	mV	meters	volts

The SOM will resume after the header is printed. This function is useful if you have disabled the Header, but need a reminder just this once.

2.9 Measure

If you type an M from the Basic Menu, you will cause one line of data to be printed immediately, for example:

102738 29.40 7.81 0.566 97.3 -0.288 5.6 12.03

It is assumed that a Header already appears on the screen to identify the readings. The SOM will resume after the line is printed. The Measure function is useful if you do not want to fill up the screen or disk with regularly-scheduled readings, but rather readings taken only at your discretion. The Measure sequence from the SOM (Space Bar M) is also easily sent by peripherals, such as Data Collection Platforms, that must request a reading every once in a while.

2.10 Identify

This function causes the DS3 to print:

Hydrolab DS3 VX.YZ TPCS%ORDB

This provides the DS3 software revision and parameters which could be supported by the DS3.

2.11 Helpful Hints

Remember that any menu answers will be accepted automatically, but that any time you type in a multicharacter response, you must hit the return key to alert the system that you are finished typing. This also gives you the opportunity to review and change any errors (with control-H or, on most computers, the backspace key) before entering the response by hitting the return key.

Remember that anytime you want to exit a menu without completing its instructions, just press Escape or Control X. You will be returned automatically to the SOM.

Remember to keep your sensors clean and well maintained. Calibration of a neglected sensor is ordinarily a waste of time.

Remember to check the readings for a parameter immediately after calibration (and the resulting automatic return to the SOM) for continued stability, and to confirm that your calibration value has been accepted.

Remember that the DS3 Multiprobe has built-in checks for calibration acceptability. If the calibration value you enter is too far out of bounds, a bell will sound and the message "Out of tolerance, calibration is not saved!" will appear and you will be returned to the SOM. You should check your calibration standard value and/or the condition of the sensor to determine why the calibration was not acceptable. PART THREE: MAINTENANCE and CALIBRATION will help.

2.12 Special Symbols in the Display or Printout

Sometimes the numbers in the data sets will be accompanied by a symbol. For instance, if the Specific Conductance reading has an asterisk (*) next to it, it means that Specific Conductance reading is based on the multiprobe's default calibration setting. The calibration, in other words, was not set by the operator.

Other symbols include a \$ by the Time reading (indicating that the Stirrer was not in operation) and an & by the Battery voltage reading (meaning that the internal batteries were providing the power). Also, an @ by the Specific Conductance or DO (mg/l) readings mean that the readings are not compensated for temperature, or salinity, respectively.



PART THREE:

MAINTENANCE and CALIBRATION

3.1 Parameter Selection

Not all multiprobes have the full complement of sensors, so select from the information of PART 3 that which pertains to your system. The multiprobe label shows your options. Use FIGURE 3.1 to identify the sensors.

Fundamentally, the multiprobe is calibrated by pouring a calibration standard into the calibration cup (or immersing the entire multiprobe in a bucket of standard) and watching the readings (for the parameter to be calibrated) in the SOM. When the readings stabilize (meaning that step-response and/or temperature transients have disappeared), the Basic Menu is accessed by hitting the terminal's space bar. Typing a C will then produce the Calibrate menu, from which the particular parameter value can be set. Section 2.5 has more menu-specific information for calibration.

You might notice that the DS3 Multiprobe has built-in checks for calibration acceptance. If a sensor's response is nowhere near what it should be for the calibration value you type in, the calibration value will not be accepted. For example, if you type in 7.02 for a pH calibration, but have accidentally immersed the sensors in a buffer of value 9.18, the message "NC" will appear, the terminal's bell will ring once, and you will be returned to the SOM. If for any reason you cannot complete calibration for any parameter, the multiprobe will continue to use the calibration from the last time that particular parameter was calibrated. However, you should try to determine why the multiprobe will not accept the new calibration (faulty sensor, bad standard, low battery, mis-typed standard value, etc.).

If any parameter values are accompanied by an asterisk (*), that value is based on a default calibration setting. This means that the multiprobe has for some reason forgotten the calibration information provided for that particular sensor, and has replaced (i.e., defaulted) it with a nominal calibration setting. So, the sensor must be recalibrated. Note that some calibrations affect other parameters. For example, loss of calibration information for specific conductance will cause an asterisk annotation for specific conductance, salinity, dissolved oxygen (ppm), and depth readings, since each is calculated from, or influenced by, the specific conductance reading.

3.2 Remarks Concerning Sensor Preparation

Sensor preparation is probably the most important action you can take to maintain or improve the quality of your field measurements. A contaminated, worn-out, or damaged sensor simply will not produce a reliable reading. It is well worth your time to set up a routine in which all sensors are serviced frequently and then allowed to rest in tap water overnight before calibration.

3.3 Temperature

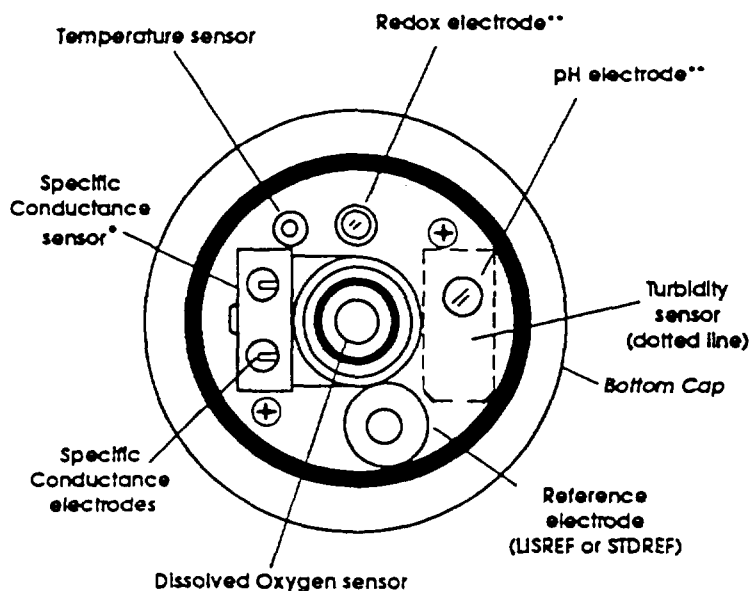
Because of the unvarying nature of the temperature sensor and its conditioning circuitry, the temperature calibration is factory-set and requires no recalibration. The sensor is built into the specific conductance probe, and requires no maintenance.

3.4 Specific Conductance and Salinity

Specific Conductance ranges are divided to maximize measurement resolution. The **fresh water cell block** (see FIGURE 3.1) provides the ranges 0 to 0.15, 0.15 to 1.5, and 1.5 to 10 milliSiemens/cm. The **salt water cell block** (see FIGURE 3.1) provides the ranges 0 to 1.5, 1.5 to 15, and 15 to 100 milliSiemens/cm. The salt water cell block should be used only if specific conductances greater than 10 mS/cm are anticipated.

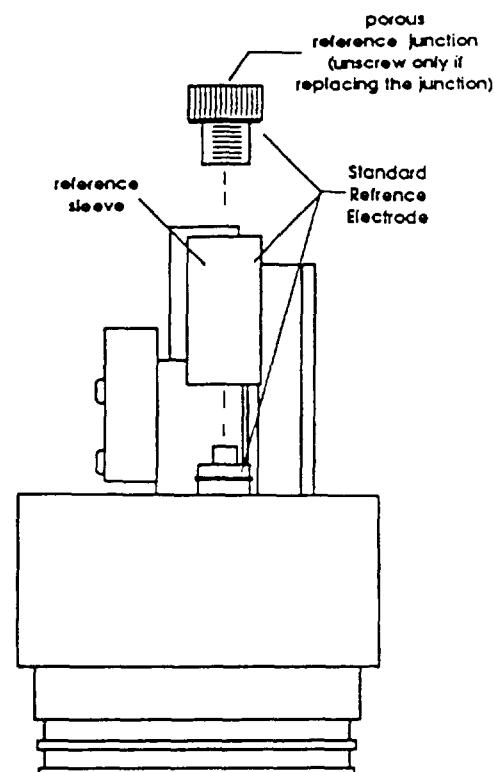
To maintain the sensor, remove the white cell block covering the six pin-shaped nickel electrodes of the specific conductance sensor. Remove the six small o-rings that are slipped over the electrodes and polish all of the exposed surface of the electrodes with the emery cloth supplied in the multiprobe's maintenance kit, or with #400 wet/dry sandpaper. Be sure to polish the ends of the electrodes, but be careful not to touch the nearby pH glass electrode with the abrasive. Clean the electrodes and the cell block with an alcohol-soaked swab.

Re-install the six o-rings (replace the o-rings if they have been flattened-out by long service). Re-install the white cell block, tightening the screws just enough to make sure the cell block is seated flat against the specific conductance sensor body. Once the sensor has been rinsed well with deionized water, it can be calibrated. It is good practice, however, to let the

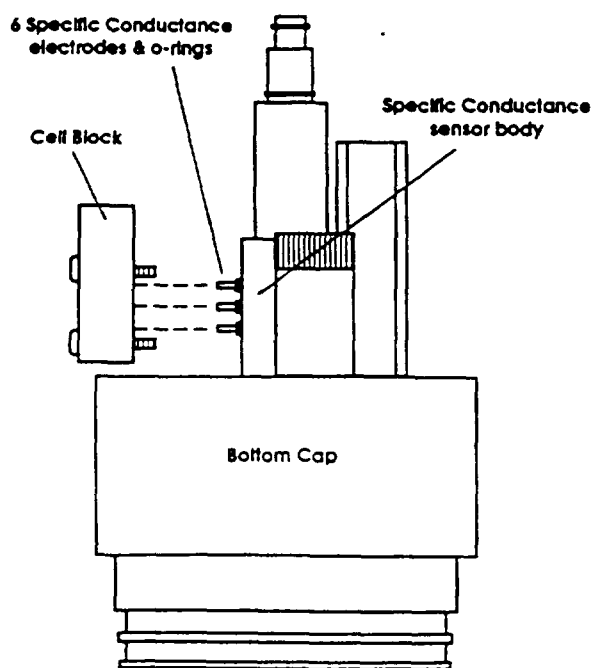


- * Depth sensor port located underneath
- ** If turbidity is installed, the pH and redox sensors are combined into a single, 'combo' sensor

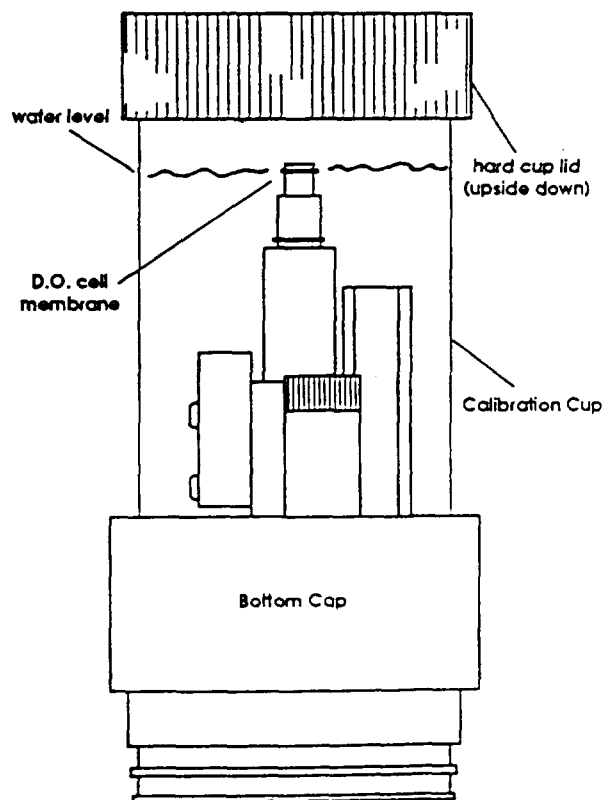
Sensor Identification



- STANDARD - Reference Electrode Maintenance



Conductivity Sensor Maintenance



Dissolved Oxygen Sensor Calibration

Figure 3.1 Sensor Maintenance & Calibration Illustrations

(continued next page)

sensor soak in tap water overnight to allow freshly-polished electrode surfaces to re-equilibrate with an aqueous environment.

When calibrating specific conductance, use a standard whose specific conductance is near that of your field samples; for instance, don't use 1M KCl to calibrate for fresh water work. Unless you are practiced in quantitative preparations, or know someone who is, you are better off purchasing prepared specific conductance standards. The following table shows several potassium chloride solutions and their specific conductance values:

KCl Molar Concentration	Specific Conductance in mS/cm
0.5	58.64
0.2	24.82
0.1	12.90
0.05	6.668
0.02	2.76
0.01	1.413
0.005	0.718
0.002	0.292
0.001	0.147
0.0005	0.074

For calibration, first make sure that the multiprobe knows which cell block is employed (section 2.6.2). Next, make sure the sensor is clean and serviced. Then:

- 1) Thoroughly rinse the sensors several times by half-filling the calibration cup with deionized water and shaking the multiprobe to make sure each sensor is free from contaminants that might alter your specific conductance standard.
- 2) In a similar manner, rinse the sensors twice with a small portion of the specific conductance standard to be used for calibration, each time discarding the rinse.
- 3) With the calibration cup screwed onto the multiprobe, sensors pointed toward the ceiling, pour in the standard to within a centimeter of the top of the cup, making sure there are no bubbles in the bores of the cell block.
- 4) Watch the specific conductance readings until they have stabilized; the sensor is now ready for calibration.
- 5) Access specific conductance from the calibrate menu, type in the calibration standard value, and hit the return key to revert to the SOM.

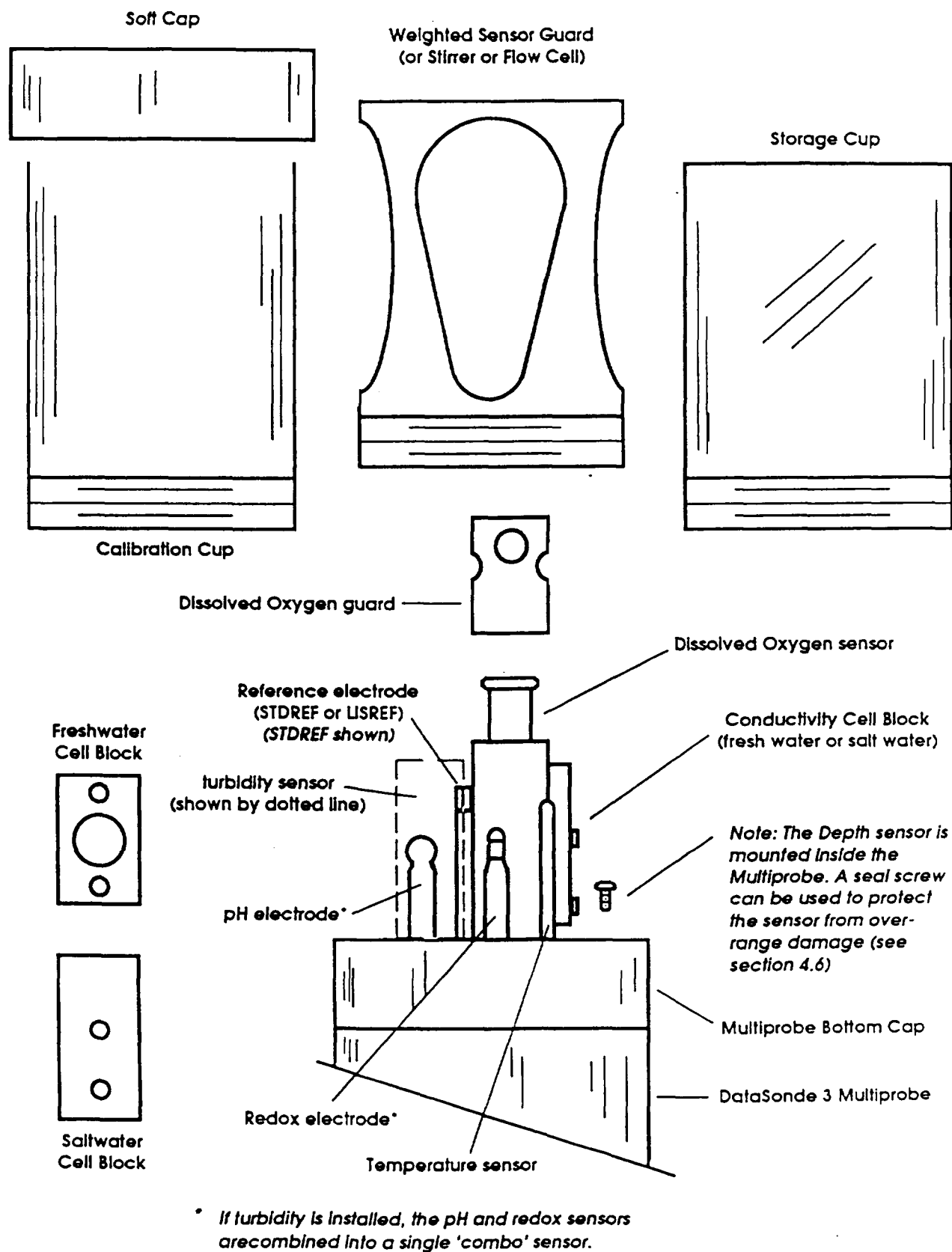


Figure 3.1 Sensor Maintenance & Calibration Illustrations (cont.)

Because the salinity parameter is algorithm-generated (section 5.5) from the specific conductance reading, once you have calibrated specific conductance, you have also calibrated salinity. However, if your field work requires salinity rather than specific conductance readings, you should calibrate salinity instead of specific conductance. Simply access salinity instead of specific conductance from the calibrate menu and type in the value (in parts per thousand at 25°C) of your salinity standard. Note that calibrating salinity simultaneously calibrates specific conductance. You cannot separately calibrate both salinity and specific conductance.

3.5 pH

The pH glass electrode requires maintenance only when obviously coated with oil, sediment, or biological growth. Clean the glass with a very clean, soft, non-scratching cloth wet with rubbing alcohol (a cotton ball will do).

Slow response or non-reproducible measurements are signs that the electrodes have become coated or clogged.

The pH glass electrode is susceptible to coating by many substances. The speed of response, normally 95% of the reading in less than 90 seconds, is dramatically changed. Usually a rinse with methyl alcohol will remove any films on the glass and restore the speed of response.

If the methanol rinse does not restore the response, soak the electrode in 0.1 Molar HCl for five minutes. Remove and rinse the electrode with water and rinse the electrode in pH buffer for 10 minutes. This should improve the response.

Servicing the reference electrode mainly involves replacing the electrolyte by gently pulling the entire covering sleeve away from the multiprobe body. Empty the remaining electrolyte from the reference sleeve, and refill the sleeve to the top with standard electrolyte: three- or four-molar KCl saturated with silver chloride.

With the multiprobe sensors pointed toward the floor, push the full reference sleeve back onto its mount until the sleeve has just covered the o-ring located on the mount (just behind the silver electrode). Now turn the multiprobe so that the sensors point toward the ceiling and push the sleeve the rest of the way onto its mount. Notice that while you are seating the sleeve, you are purging any air trapped in the electrolyte chamber, and are

using the air and excess electrolyte to flush and clean the porous junction on the tip of the sleeve. This junction is the most important part of the pH system; make sure it is clean and passes electrolyte readily. If not, replace it with the spare in the maintenance kit.

The pH system can now be calibrated. However, it is a good idea to let the electrodes re-equilibrate overnight in tap water after being cleaned, especially if you have used alcohol.

pH calibration is accomplished by filling the calibration cup first with the "zero" buffer (value between 6.8 and 7.2) and then with a "slope" buffer whose pH is near that of the anticipated samples to be measured (but not between 6.8 and 7.2). For each buffer, once the reading has stabilized, follow the calibration procedure detailed in section 2.5.1. Always rinse the sensors thoroughly with deionized water between buffers.

The general-purpose Hydrolab reference electrode is designed for normal field application: measurement of middle-range ionic strength waters to about 150 meters depth. For use in very low ionic-strength waters (generally, those under 0.2 mS/cm specific conductance), measurement reliability can often be enhanced by the LISREF (an optional one-piece, white, bullet-shaped "low ionic-strength reference electrode" that does not require electrolyte replacement). The LISREF requires a maintenance procedure different from that prescribed for the rebuildable Hydrolab reference.

First, and most importantly, the tip of the LISREF should be soaked in 4-molar potassium chloride whenever the system is not in use; for instance, overnight when the instrument is in daily use. Fill with KCl the black cap provided with the LISREF (or a similar cap) and install it on the LISREF for this storage procedure, since the other sensors, such as the pH glass itself, should be stored in plain tap water. This step facilitates a reference junction that is homogeneously saturated with strong electrolyte, a condition necessary for stable and accurate readings in dilute samples. Be sure to remove the black cap for calibration or field use.

As a rule of thumb, make sure the LISREF reference electrode is soaked in KCl as long, per week, as it is exposed to sample waters.

Second, always keep the LISREF clean by rinsing with soapy water to remove visible contamination, and by wiping the sensor occasionally with a cloth soaked in rubbing alcohol to remove oils and grease that might have accumulated. The sensor should be soaked in KCl at least 24 hours after cleaning, then recalibrated before field use.

Third, check the sensor's span frequently by calibrating with standard buffers and then checking performance with a standard whose ionic strength approximates that of the anticipated field samples. Calibration with standard buffers alone is no guarantee of measurement quality in low ionic-strength samples (see section 5.4.5).

Slow response or non-reproducible measurements are signs that the electrodes have become coated or clogged.

The pH glass electrode is susceptible to coating by many substances. The speed of response, normally 95% of the reading in less than 90 seconds, is dramatically changed. Usually a rinse with methyl alcohol will remove any films on the glass and restore the speed of response.

If the methanol rinse does not restore the response, soak the electrode in 0.1 Molar HCl for five minutes. Remove and rinse the electrode with water and rinse the electrode in pH buffer for 10 minutes. This should improve the response.

See section 3.11 for information on pH "warm-up".

3.6 Redox

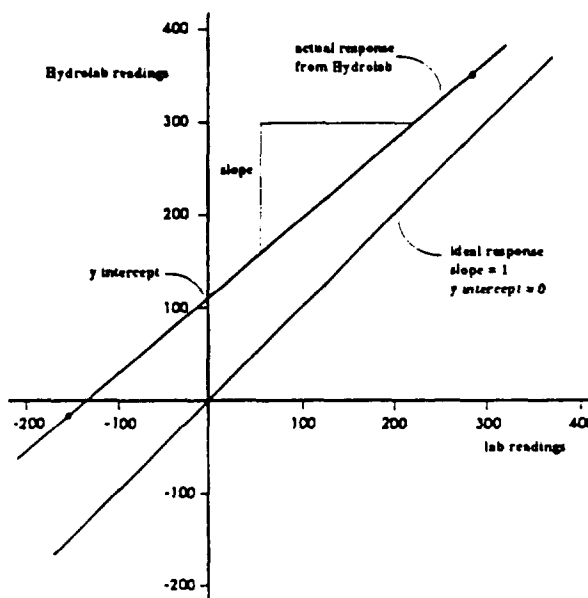
Generally the Redox sensor requires the same infrequent cleaning procedure as the glass pH electrode. Should the platinum band at the tip of the Redox sensor get really dirty and discolored, it can be polished with a clean cloth and a very mild abrasive, such as toothpaste; or use a fine polishing strip. After polishing, the sensor should be allowed to soak overnight in tap water so that the platinum surface can restabilize.

As long as the platinum band of the Redox sensor and the reference electrode are kept properly serviced, you may not need to frequently check the Redox system calibration. However, you can verify your Redox system performance by dissolving a few grams of quinhydrone in 500 ml of 4- and 7-pH buffers. For the temperatures of 20°, 25°, and 30°C, respectively, the Redox values for the pH 4 solution are 470, 462, and 454; for the pH 7 solution 295, 285, and 275. These Redox values are in millivolts (European sign convention) and are based on the standard hydrogen reference electrode. Note that Hydrolab uses a silver-silver chloride reference electrode instead of the hydrogen reference electrode. This means that, without calibration, each of your readings will differ by about +200 millivolts from the traditional values that are based on the hydrogen electrode. Calibration, however, removes this offset.

Alternatively, you can calibrate with any solution (with a stable Redox) by reading the Redox on a trusted laboratory meter, and using this solution for your standard. Remember that the laboratory meter is likely to use a silver-silver chloride reference electrode; add 200 millivolts to its readings if you want your Hydrolab readings to be based on the hydrogen standard. Select a standard value near that of your field samples.

See section 3.11 for information on Redox "warm-up".

Standardizing Redox Readings: The Redox values of quinhydrone solutions vary with pH. So, two quinhydrone solutions of suitably different pH's can be used to "calibrate" Redox readings. Suppose, after plenty of time for sensor equilibration, a trusted laboratory instrument gave readings of 275 and -150 millivolts for two quinhydrone solutions. At the same temperature, a properly-maintained Hydrolab gave readings of 350 and -30 mV, respectively. The graph below shows the plotted results.



The line created by the two Hydrolab readings showed a y-intercept of about 104 and a slope of about 0.89. These numbers are calculated as follows:

$$\text{slope} = (350 + 30) / (275 + 150) = 0.894 \quad (\text{from } m = \text{rise/run})$$

$$\text{y intercept} = -30 - 0.894(-150) = 104 \quad (\text{from } y = mx + b)$$

Thus, the Hydrolab readings must first be decreased by 104 mV, and then divided by 0.894 to get the correct reading (that is, the reading that matches the laboratory instrument's reading). For instance, suppose the Hydrolab gave an equilibrated reading of 350 mV for some field sample. The "corrected" reading would be:

$$350 - 104 = 246, \text{ and then } 246 / (0.894) = 275 \text{ mV}$$

We know that this is the right answer, because 350 and 275 are two of the comparison points from the original quinhydrone solutions.

However, assuming that the laboratory instrument is using a silver-silver chloride reference electrode, the corrected Hydrolab reading must be increased by about 200 mV to match it to the standard hydrogen reference electrode (the basis upon which most published half-reaction potentials are based):

$$275 + 200 = 475 \text{ mV.}$$

Thus, the real Redox potential of the solution is not 350, but 475 mV.

3.7 Dissolved Oxygen

DO sensor maintenance is usually required only when calibration becomes impossible or when the membrane covering the cell becomes wrinkled, bubbled, torn, dirty, or otherwise damaged. It is, however, good practice to replace the membrane on a regular schedule, before trouble becomes visible. Frequent electrolyte changes will maximize the life of the sensor.

Please read APPENDIX 1 for information on the two methods available in the DS3 for measurement of DO.

To change membranes, remove the white DO sensor guard and the o-ring securing the membrane. Shake out the old electrolyte, rinse with deionized water, and refill with fresh electrolyte (provided in the Maintenance Kit, or use 2M potassium chloride) until there is a perceptible meniscus of electrolyte rising above the entire electrode surface of the sensor. Make sure that there are no bubbles in the electrolyte. Hold one end of a new membrane (either Standard or LoFlow) against the body of the DO sensor with your thumb and with a smooth, firm motion, stretch the other end of the membrane over the sensor surface and hold it in place with your

index finger. Secure the membrane with the o-ring. Note: When applying a LoFlow membrane, be sure to stretch the membrane just enough to have it conform to the sensor without wrinkles. If you stretch it too tight, the readings will be too high for calibration. If such is the case, simply replace the membrane, without quite so much stretch, and recalibrate. There should be no wrinkles in the membrane or bubbles in the electrolyte. Trim away the excess membrane extending below the o-ring.

The DO sensor is now ready for calibration, but you should let it soak overnight to give the membrane time to relax to its final shape (i.e., calibration condition).

To calibrate DO:

- 1) With the multiprobe oriented so that the sensors are pointed toward the ceiling, fill the calibration cup with tap water (specific conductance less than 0.5 mS/cm) until the water is just level with the o-ring used to secure the membrane.
- 2) Carefully remove any water droplets from the membrane with the corner of a tissue.
- 3) Turn the blue calibration cup cover upside down (concave upward) and lay it over the top of the calibration cup.
- 4) The sensor is ready for calibration once the readings have stabilized. Just follow the instructions printed by the multiprobe; refer to sections 2.5.4 and 2.5.5 for calibration menu details.

You can also calibrate the DO system in a well-stirred bucket of temperature-stable, air-saturated water. This situation more closely resembles the actual field measurement conditions.

Remember that the two batteries in the multiprobe can power the oxygen sensor (and the pH and Redox circuits) continuously, so that a stable reading is always available quickly. (Generally, the polarizing batteries are used only with the LoFlow Membrane.) If you know that the multiprobe is not going to be in use for an extended period, say a week or more, you can extend the life of the two cells and of the oxygen sensor by removing the sensor's membrane, removing all of the sensor's electrolyte, and installing a membrane over the dry sensor. For best results, replace the electrolyte and membrane the day before calibration for the next deployment.

When using the polarizing batteries, you can greatly prolong the life of the sensor by changing the electrolyte frequently (twice or more a month), and/or by removing the electrolyte when the sensor is *not to be used for a week or more*. (Remove electrolyte or 2.7V batteries when DS3 is not in use.)

3.8 Depth

Generally, the depth (or level) sensor needs no maintenance. Occasionally, you may wish to squirt a very weak acid (such as acetic) into the depth sensor port (the hole in the face of the bottom cap that seems to have no use) with a hypodermic syringe if you notice deposits (calcium, biological growth, etc.) forming in the port. Calibration access information is found in section 2.5.7.

Normally, calibration is done by simply entering zero for the standard at the water's surface. However, if you have another method, such as a carefully-marked cable, you can type in any number you wish when calibrating.

Because the density of water varies with its specific conductance, the depth readings must be corrected for specific conductance. This correction is applied linearly from zero specific conductance (no correction) to 100 mS/cm. At 52 mS/cm (seawater's specific conductance), the correction reduces the actual reading by 3 percent.

Note that there are two depth sensors: 0 to 100 meters (328 feet) and 0 to 10 meters (33 feet). The former is usually used to determine the depth at which readings of the other parameters are being made. The latter is often used to detect level changes, such as those accompanying tidal flows or rainfalls. The level sensor should be protected from depths over 20 meters (66 feet) by installing the sealing screw (found in the maintenance kit) in the face of the bottom cap. Likewise, the depth sensor should be protected from depths over 150 meters (492 feet) by installing the sealing screw.

3.9 Care of the Multiprobe

Besides normal maintenance of the sensors and the internal batteries, just keep the multiprobe cleaned with soap and water. Always use the calibration cup or the storage cup (filled with tap water) to protect the sensors from damage, and especially from drying out, whenever the multiprobe is not deployed.

Remember: When using the polarizing batteries, you can greatly prolong the life of the sensor by changing the electrolyte frequently (twice or more a month), and/or by removing the electrolyte when the sensor is not to be used for a week or more.

Always rinse the multiprobe with clean water soon after returning from deployment.

3.10 Care of the Cables

Just keep these parts clean and off the floor. Additionally, some connectors, such as any that plug into a terminal, are not waterproof and so must be kept dry at all times.

Protect the cables from abrasion, unnecessary tension, repetitive flexure (fatigue), and bending over sharp radii (like the edge of the side of a boat). Excessive weight added to the transmitter (10 pounds or more) can greatly increase the possibility of cable breakage due to stress on the mold and attachment points.

When not in use, cables should be clean, dry, and stored, neatly coiled, in a plastic bag.

3.11 Changing the Dissolved Oxygen/pH Sensor Batteries

If your DS3 Multiprobe is equipped to measure dissolved oxygen (DO), Redox, or pH, you need to decide whether or not to use the DS3's internal polarizing batteries. These are two Mallory TR-132R (or equivalent) 2.7 volt mercury batteries. When installed inside the multiprobe, they eliminate the need to wait over two minutes for stable readings once the multiprobe has been turned on.

The polarizing batteries are shipped in the maintenance kit. Install them if you wish to eliminate the two-minute "warm-up" time for pH or the Standard Membrane DO sensor. (Warm-up times are approximate and can change with such variables as temperature.)

Remember that using the batteries can shorten the life of the DO sensor. Be sure to remove the electrolyte from the sensor if it is not going to be used for an extended time. Also, when the sensor is in use, change the electrolyte once every week or so to extend sensor life.

Here's an example of when to use, or not use, the polarizing batteries: Joe had three multiprobes that he was using to monitor fish-rearing tanks. The multiprobes were equipped with Standard Membrane DO sensors and pH sensors, and Joe needed measurements from all three tanks every 15 minutes. Joe elected to use the multiprobes without polarizing batteries, since

he could program his computer to turn each multiprobe on for five minutes - more than enough time to produce stable readings for pH and Standard Membrane DO.

However, things worked out so well that six months later Joe added 27 more tanks. Now, he can turn each multiprobe on for at most 30 seconds - not enough time to guarantee stable readings without the polarizing batteries. So, Joe installed the polarizing batteries in all his multiprobes and adopted a new maintenance plan that required weekly electrolyte and membrane changes for the DO sensors.

Had Joe been using the LoFlow Membranes, he would always have had to use the polarizing batteries, since even two minutes is not a long-enough warmup for the LoFlow Membrane.

To change or install the batteries, first put the dummy cap back onto the 6-pin bulkhead connector (if you have a detachable cable). Don't leave the sensors unguarded; always attach either the storage cup or calibration cup to the multiprobe. Take the multiprobe over to the sink and scrub it all over with a vegetable brush and soapy water.

When it is cleaned and dried, remove the two Allen screws that hold the multiprobe's bottom cap (the cap with the sensors) fixed in the multiprobe's tubular body. Now carefully and slowly (with a slight twisting motion) remove the bottom cap, using, if necessary, a large screwdriver blade between the cap and multiprobe body (just to get it started). Pull the cap out only about six inches (it is very tight and might come free suddenly; don't fling it across the room). Lift the cap straight out of the housing, slowly, until you can see the wires connecting the multiprobe's external connector (the one at the top of the multiprobe) to the rectangular circuit boards. Carefully detach the wires' connector from the exposed circuit boards so that you can finish pulling the circuitry out of the tube. Set the tube aside, making sure that no contaminants enter the opened end.

Now, remove the spent batteries from their holders and replace them with fresh batteries; observe the polarity markings of the battery holders. Re-install the retaining clips.

Examine the o-rings on the cap and the area inside the tube which seats the o-rings. Is there any sign of nicks, gouges, or flattening of the o-rings? Is the seating area undamaged? Is everything incredibly clean; no sand, hair, grit, dirt, sediment, sticks, etc.? Is there a light coat of white silicone grease (supplied in the maintenance kit) present? This is the Moment of Truth. If you are in a big hurry at this point, check the price of a new multiprobe before proceeding.

When you are satisfied that the o-rings and seats are ready for re-assembly, slide the circuitry back in the tube, remembering to reconnect the wires to the circuit board as they were connected before. Now push the bottom cap back into the tube (with a slight twisting motion). Add a small amount of anti-seizing compound or light grease to the Allen screw threads to prevent seizing of screws and replace the screws with a small Allen wrench (just finger-tight). DO NOT OVER-TIGHTEN!

These batteries power the dissolved oxygen sensor (and pH and Redox amplifiers) continuously, so that a stable reading is always available. (When these batteries are changed, be prepared to wait a few hours or overnight for the DO sensor to restabilize.) If you know that the multiprobe is not going to be in use for an extended period, say a week or more, you can extend the life of the two batteries and of the oxygen sensor by removing the membrane and all of the electrolyte, and installing a new membrane over the dry sensor. For best results, replace the electrolyte and membrane on the day before calibrating for the next deployment.



PART FOUR: DEPLOYMENT

4.1 Deployment in Open Waters

4.1.1 Long-term Deployment in Open Waters

If you are using the multiprobe in open water, try to locate the multiprobe so that any available protection is utilized. For instance, in a swiftly flowing river, anchor the multiprobe to the downstream side of a bridge piling so that floating debris will strike the piling, not the multiprobe. Likewise, in a recreational lake deployment, use a marking buoy that will not attract the attention of vandals.

The multiprobe can be anchored by running a rope or chain through the bail. The bail is fixed into the two eyebolts on the top of the multiprobe by turning one eyebolt 90° (and then back) so that the bail can be looped through it. Be sure to run the bail through the eyebolt on the cable. This way, the weight of the multiprobe is suspended from the breakout, via the bail, and no weight is on the cable-to-multiprobe connectors.

Try to fix the multiprobe in an upright or on-side position, and avoid areas that might see deep deposits of sand, gravel, or silt in the case of a heavy rainfall event. Being caught in water that is icing over can also cause the loss of the multiprobe.

Take similar precautions with the cable to protect it from floating debris, navigation, and vandals.

Always make sure the screw-on sensor guard is installed. Use of the DO sensor guard is also recommended, though some operators may elect to run the DO cell unguarded to make the best use of low sample flows.

Be sure to remove the black storage cap from the reference electrode if your multiprobe is equipped with Hydrolab's optional low ionic-strength reference electrode (the LISRE; see Section 3.5).

Some sensors cannot remain in calibration for long periods in certain situations. For instance, a DO cell may become hopelessly fouled after just a few days in a warm, shallow, biologically-active lake. Likewise, a reference electrode's performance will begin to deteriorate quickly in a flowing stream of low ionic-strength water. On the other hand, if the only parameters being measured are temperature and conductivity, the multiprobe can be left for weeks in a clean-water lake. The decisions regarding deployment time are best based on experience; however, deployment time can be judged by mak-

ing periodic (say, daily) measurements of sensitive parameters with another instrument. The day on which the spot-measurements and the logged data begin to diverge significantly may be considered the maximum deployment time for that particular water and season.

4.1.2 Short-term Deployment in Open Waters

Generally, short-term deployment implies hand-held operation. Just follow common sense; for instance, don't lower the multiprobe into the water without screwing on the sensor guard or the stirrer. Watch out for hazards such as outboard motor propellers. Protect the terminal from dampness and mechanical shock.

Be sure to run the bail through the eyebolt on the cable's molded breakout, also. This way, the weight of the multiprobe is suspended from the breakout, via the bail, and no weight is on the cable-to-multiprobe connectors. You can weight the multiprobe (for faster sinking) by attaching large lead fishing weights (or scuba weights, or barbell weights, or ...) to the guard. Do this with 25-pound test monofilament line (or Velcro™), so that if the weights become fouled on an underwater hazard, you can break the line and free the multiprobe. Don't use more than about 10 pounds of add-on weight.

4.2 Using the Stirrer

If you are working with the Standard Membrane DO system (rather than the LoFlow™ Membrane system; see Appendix 1), you will ordinarily operate with a stirrer to provide adequate flow for reliable readings. The stirrer screws into the multiprobe's bottom cap, and is powered by attaching its power lead to the cable (requires the stirrer connector option). The battery powers both the multiprobe and the stirrer. If you do not need any data for an extended time, disconnect the battery to extend its life.

The operator may specify whether the stirrer is to be turned on or not during operation (see Section 2.6.9). This makes it easy to turn the stirrer off when it is not needed (to save power), but is especially designed for having the stirrer turned on and off, automatically, at the proper times during unattended logging.

4.3 Flow Cell Operation

For process or pump-through situations, the Hydrolab flow cell can be attached to the multiprobe so that the system does not have to be submerged in the water being studied. This device simply screws on in place of the storage cup. Don't exceed a pumping rate of about 1.5 liters per minute; that should change the contents of the flow cell about eight times per minute.

WARNING: DO NOT LET THE PRESSURE IN THE FLOW CELL OR ITS FEED LINE EXCEED 15 PSIG. HIGHER PRESSURES CAN BURST THE FLOW CELL, POSSIBLY CAUSING SERIOUS BODILY INJURY TO THE OPERATOR AND/OR BYSTANDERS.

Filter debris from the feed line if necessary. If possible, invert the multiprobe so that bubbles will tend to float away from the sensors and out the port on the bottom of the flow cell.

4.4 Pressure and Temperature Extremes

Don't send your multiprobe more than 150 meters (about 490 feet) deep. Note that there are two depth sensors: 0 to 100 meters (about 325 feet) and 0 to 10 meters (about 35 feet). The stage sensor (the latter) should be protected from depths over 20 meters (about 65 feet); install the sealing screw (found in the maintenance kit; see Figure 3.1) in the face of the bottom cap for this protection. If you are sending your 100-meter depth sensor much over 100 meters, you should use the sealing screw also.

The multiprobe's operating temperature range is -5°C to 50°C (about 23°F to 122°F). Exposure of the multiprobe to temperatures outside of this range might result in mechanical damage or faulty electronic performance. The latter may be very subtle.

4.5 Data Transmission Lines

If you are adding transmission cable to your cable, the added cable must be large enough to carry the operating current and transmit data without distortion. For up to a total of 1000 feet of cable, three #26 AWG wires is suitable for data transmission, but two #18 AWG must be used for the power wires. Alternatively, smaller power wires can be used if the power supply is located closer to the multiprobe.

For instance, if a lake is 50 feet deep and the computer to which the multiprobe is connected is 950 feet away from the lake, you would be wise to buy a 50-foot cable for the multiprobe and supply the other 950 feet yourself with cheaper wire. Attaching the battery at the shore of the lake (instead of near the computer) will further save you the cost of the large wires required for power transmission.

Note that a stirrer can add significantly to voltage losses in cables. If your installation requires a circulator, it is a very good idea to locate the battery as near the multiprobe as possible.

If you cut into the body of the cable (i.e., not interfering with the connectors at either end), consult the "Connector and Current Reference Chart" and "Wiring Charts" included in Appendix 4 at the end of the manual.

100%



PART FIVE:

TECHNICAL NOTES

5.1 Dissolved Oxygen Temperature and Salinity Corrections

There are five components to the dissolved oxygen concentration (i.e., mg/l) reading: the "raw" sensor reading, a scale factor, the membrane temperature correction, the solubility temperature correction, and the salinity compensation. The raw reading is a function of the DO cell itself, and is related to the sensed partial pressure, not concentration, of oxygen dissolved in the sample. The scale factor is set by the operator during calibration. The membrane temperature correction is determined experimentally for each type of membrane. The solubility temperature function corrects for effect of temperature on the solubility of oxygen in water. The salinity function corrects for the effect of salinity on the solubility of oxygen in water.

The function used for membrane temperature correction at a temperature T (°C) for the Standard Membrane (1-mil Teflon) is:

$$F(T) = 2.2513 (10^{-7}) T^4 - 3.3116 (10^{-5}) T^3 + 2.2366 (10^{-3}) T^2 - 9.3778 (10^{-2}) T + 2.3761$$

The function used for membrane temperature correction at a temperature T (°C) for the Hydrolab LoFlow Membrane is:

$$F(T) = 7.6233 (10^{-7}) T^4 - 1.2322 (10^{-4}) T^3 + 8.2111 (10^{-3}) T^2 - 2.8240 (10^{-1}) T + 4.5557$$

In both cases, the raw DO signal is multiplied by $F(T)$ to produce the temperature-corrected reading, so divide the DO reading by $F(T)$ to un-correct for temperature.

The function used to convert DO % Sat to salinity-uncompensated DO mg/L is:

$$FC(T) = 100 / (7.2541 (10^{-9}) T^5 - 5.1387 (10^{-7}) T^4 + 9.8316 (10^{-6}) T^3 + 5.2276 (10^{-4}) T^2 + 0.19665 T + 6.8356)$$

The DO % Sat reading is divided by $FC(T)$, so multiply the DO mg/L reading by $FC(T)$ to uncompensate. The data used to generate this polynomial comes from the oxygen solubility data in the 1985 Standard Methods.

The function used to salinity-compensate DO (to "true" DO) for a specific conductance C (mS/cm) at a temperature T (°C) is:

$$F(C) = 1 - C(3.439 (10^{-3}) + 0.361 / (22.1 + T)^2)$$

The raw DO signal is multiplied by F(C) to produce the salinity-compensated reading, so divide the DO reading by F(C) to un-correct for salinity. The data used to generate this polynomial comes from the oxygen solubility vs. chlorinity data in the 1985 Standard Methods.

Note that DO % saturation is not a function of solubility, and so has neither a salinity correction nor temperature correction for solubility.

5.2 The LoFlow Membrane Flow Optimization Factor

When sample flow is stopped (i.e., reduced to about one cm per minute), it is the nature of Hydrolab's LoFlow Membrane to fall to about 95% of a full-flow reading. The same sensor with a Standard Membrane (1-mil Teflon) will fall to about 50% of a full-flow reading under the same conditions (full-flow is taken to be 25 cm/sec or greater). To optimize the LoFlow sensitivity of -5% to $\pm 2.5\%$ (due to flow), the LoFlow readings are automatically boosted by 2.5%.

This means that if a sample of water is at exactly 8 mg/l DO concentration, the LoFlow would read 8.2 mg/l, while the Standard would read 8. If flow was cut to near zero (i.e., one cm/minute), the LoFlow would read 7.8, while the Standard would read about 3.2.

5.3 Dissolved Oxygen Altitude-Pressure Function

When you are in the DO mode of the Calibrate menu and the Terminal asks you for the local barometric pressure, BP, in millimeters of mercury, you can estimate this number using:

$$BP = 760 - 2.5 (A/100)$$

"A" is your local altitude above sea level in feet. Also, if you are using the BP given by your local weather bureau, remember that their numbers are corrected to sea level, and you must use BP', the un-corrected atmospheric pressure:

$$BP' = BP - 2.5(A/100)$$

5.4 Specific Conductance

5.4.1 Specific Conductance Temperature Standardization

Conductivity is a measure of a water's ability to conduct electricity, and therefore a gross measure of the water's ionic activity. Generally, the higher a water's concentration of ionized impurities, the higher its conductivity. However, the capacity of those impurities to conduct electricity varies with temperature. The conductivity of a water sample heated from 15°C to 35°C changes greatly during the heating.

On the other hand, specific conductance is the conductivity measured when a water's temperature is fixed at 25°C. Unlike conductivity readings, specific conductance readings are easily compared if the readings are made at different temperatures, for instance in a lake during various seasons.

The function (based on 0.01N KCl) used to standardize conductivity to 25 °C for the temperature, T (°C), when the Freshwater cell block is used is:

$$F(T) = 1.4326 (10^{-9}) T^5 - 6.0716 (10^{-8}) T^4 - 1.0665 (10^{-5}) T^3 + 1.0943 (10^{-3}) T^2 - 5.3091 (10^{-2}) T + 1.8199$$

The raw signal (i.e, conductivity) is multiplied by F(T) to produce the temperature-standardized reading (i.e, specific conductance), so divide the specific conductance reading by F(T) to de-standardize for temperature (i.e, produce the conductivity reading).

The function (based on seawater) used to standardize conductivity to 25 °C for the temperature, T (°C), when the Saltwater cell block is used is:

$$F(T) = 1.2813 (10^{-11}) T^7 - 2.2129 (10^{-9}) T^6 + 1.4771 (10^{-7}) T^5 - 4.6475 (10^{-5}) T^4 + 5.6170 (10^{-3}) T^3 + 8.7699 (10^{-4}) T^2 - 6.1736 (10^{-2}) T + 1.9524$$

The raw signal (i.e, conductivity) is multiplied by F(T) to produce the temperature-standardized reading (i.e, specific conductance) so divide the specific conductance reading by F(T) to de-standardize for temperature (i.e, produce the conductivity reading).

These corrections are based on reference data over the 0 to 30°C range (from USGS Water Supply Paper 2311). An optimization of the characteristics of both salt and fresh waters is used for temperatures outside the 0 to 30°C range. If you need a more specific correction, then record your data as

uncompensated conductivity (Section 2.6.2). Later, you can apply your own temperature correction to the data (for instance, in a spreadsheet).

Because resistivity is calculated from the temperature-corrected conductivity (i.e, specific conductance) reading, resistivity also has the above correction, as do salinity and total dissolved solids (TDS).

5.4.2 Specific Conductance to Salinity Conversion

The function used to convert specific conductance, C , to salinity, S , is:

$$S = 5.9950 (10^{-8}) C^4 - 2.3120 (10^{-5}) C^3 + 3.4346 (10^{-3}) C^2 + 5.3532 (10^{-1}) C - 1.5494 (10^{-2})$$

This relationship is taken from the USGS Water Supply Paper 2311. Note that while any specific conductance can be converted to salinity, salinity is defined only for mild dilutions and concentrations of seawater (say, the 30 to 40 ppt salinity range).

Note that salinity, unlike specific conductance, the parameter from which salinity is calculated, is not actually "temperature compensated". A part-per-thousand is a part-per-thousand, no matter what the temperature. However, the above conversion algorithm only works for conductivity readings that have been corrected to 25°C (i.e, specific conductance readings).

If you have more specific information on your particular samples, then record conductivity instead of salinity and, with a spreadsheet, calculate salinity from those readings.

5.4.3 Specific Conductance to Resistivity Conversion

Resistivity is simply the inverse of specific conductance. For example, the resistivity corresponding to 100 microSiemens/cm (0.1 milliSiemens/cm) is 10.0 K ohm cm.

5.4.4 Specific Conductance to Total Dissolved Solids (TDS) Conversion

TDS is calculated from specific conductance as:

$$\text{TDS} = C(0.640)$$

where TDS is total dissolved solids in K mg/l (i.e, g/l) and C is specific conductance in mS/cm (from Water Chemistry, by Snoeyink and Jenkins).

If you have more specific information on your particular samples, then record specific conductance instead of TDS and, with a spreadsheet, calculate TDS from the specific conductance readings.

5.4.5 Correcting Depth for Specific Conductance

The density of water, and hence its ability to "create" pressure, increases with specific conductance. Therefore, if a depth transducer is calibrated for fresh water, the depth reading must be reduced for measurements made in salt waters. The following correction is used for depth (and level) readings:

$$F(C) = 1 - 0.03(C/52)$$

C is the measured specific conductance in mS/cm. The raw depth readings are multiplied by F(C) to produce the displayed reading. In effect, no correction is made at zero specific conductance, and readings are reduced by three percent at 52 mS/cm, the specific conductance of sea water.

5.4.6 Specific Conductance Less Than 0.2 milliSiemens/cm?

If you make pH or conductivity measurements in water whose conductivity is less than 0.2 milliSiemens/cm, please contact Hydrolab. Making measurements in very dilute solutions is a whole different ballgame, especially for pH. See the "Application Note on pH Measurements" located at the back of your multiprobe Operating Manual.

5.5 Turbidity

5.5.1 *Measurement Principle*

The ISO-7027 specification calls for a nephelometric detector at 90 degrees from an infrared light source of 860 nm. Hydrolab's turbidity sensor, when operated in nephelometric mode, meets all these specifications except the light source is at 880 nm.

The ratio mode adds a transmissive correction to eliminate the "blinding out" phenomenon common in nephelometric instrumentation at high turbidities.

Selection of mode is highly dependent upon your data requirements, adherence to any measurement specifications, and your primary range of measurement.

5.5.2 *Ambient Light*

The multiprobe measures the sensor responses when the light source is on and when it is off. The difference between the on and off responses is used to eliminate the effects of ambient light and provide the turbidity measurements.

But there is a limit to the amount of ambient light which can be rejected. If the ambient light "saturates" the sensors, then the on and off responses to the light source will be nearly the same. Incorrect turbidity values are produced. The multiprobe can detect when the ambient light is causing questionable turbidity data. When this condition is detected, a "?" is printed next to the turbidity data value.

The maximum ambient light threshold is equivalent to the amount of light reaching the sensor at a 1m submersion in "turbidity-free" water at full sunlight. At 1m deep, infrared light detected by the sensor is attenuated to 1%.

5.5.3 *Light Source Variation*

The light source output varies tremendously from part to part and over temperature. A third sensor was added to measure the light output and normalize the nephelometric and transmissive sensor responses.

Additionally, this third sensor allows the multiprobe to detect a faulty light source. The photodiode measures the light source output to insure proper operation. If the light source output becomes too low, a "?" is printed next to the turbidity data. To determine if the "?" is caused by ambient light or a faulty light source, shield the sensor from ambient light. If the "?" disappears, then the ambient light is too high. Otherwise, please contact Hydrolab Customer Service.

5.6 The DS3 Multiprobe's RS-232 Communication Mode

Please consult the "Wiring Charts" (Appendix 4) for information on RS-232 wiring.

To establish communication with the multiprobe, have your RS-232 device take the Transmit (TXD) line "active" (i.e., < -3 volts). The multiprobe will immediately begin sending data (in the Standard Operating Mode) at 1200 baud, eight bit, no parity, one stop bit. To sever communication, simply take the Transmit (TXD) line "inactive" (i.e., > -3 volts).

If you are writing a data-receiving program for your RS-232 device, here is a good method for obtaining one header line and one data line:

- 1) Take the Transmit (TXD) line active and ignore all data for 30 seconds.
- 2) After the 30 seconds, have your RS-232 device send a "space-bar" and an "H" to have the multiprobe send the header and label. (This step is optional; don't use it if you have no need for the header or label information.)
- 3) Now have your RS-232 device send a "space-bar" and an "M" to have the multiprobe send one line of data.
- 4) Now take the Transmit (TXD) line inactive to end communication until the next data is desired.

The 30-second delay is to allow the sensors to fully warm up, and to avoid the first information sent by the multiprobe (since you may not want all of that information sent to be saved by your RS-232 device). If you are not using the multiprobe's internal polarizing batteries (Section 3.11), you may want to use a longer warm-up delay.

5.7 Performance Measurement and Improvement

This manual was designed to best meet the needs of the "average" operator. However, if you have an application that demands increased performance or operation under unusual circumstances, Hydrolab Corp. is willing and able to help. Just call 800-949-3766 or 512-255-8841. Hydrolab's staff of engineers and application experts will be more than happy to share with you their years of experience in helping operators get good data under demanding field conditions. Just call.



PART SIX:

TROUBLESHOOTING

NOTE: For troubleshooting the operation of a Hydrolab Display, see your display's operating manual.

- **Multiprobe will not start printing:**

- a) Are all connectors mated properly?
- b) Is the battery voltage is between 9 and 18 volts?
- c) Is the terminal on and set to 1200 baud, 8-bit, no parity?
- d) Have you properly booted a communications program, if needed?
- e) Is your interface cable compatible with your terminal?
See Sections 1.1, 5.6 and the wiring charts (Appendix 4).

- **Data is printed without header information:**

- a) Is the header function enabled? See Section 2.6.7.

- **Only one data line is printed:**

- a) How is the interval set? See Section 2.5.9.

- **Typed command is not accepted; functions cease:**

- a) Did you type in the required number of characters? For instance, the answer to the HHMMSS: question must consist of exactly six numeric characters.
- b) Did you hit the return key after typing in a multicharacter answer?
- c) Is your PC's serial port operational? Are the cables still connected?

• **"Out of tolerance, calibration is not saved!" message printed:**

- a) Are you sure of the value of your calibration standard?
- b) Are the sensors properly serviced? See PART THREE.
- c) Did you type in the value of your calibration standard correctly, and in the proper units?

• **Dissolved Oxygen readings are too low to calibrate, and/or pH and/or Redox readings are very high or very low:**

- a) Are you sure of the value of your sample solution?
- b) Are the multiprobe's polarizing batteries fresh? These batteries should be changed every six months. Note that these batteries, when installed, can shorten the life of the DO sensor. See Section 3.11.
- c) Are the sensors properly maintained? See PART THREE.

• **Conductivity, Temperature, and/or Depth readings seem wrong:**

- a) Are the sensors maintained and calibrated properly? See PART THREE.
- b) Are you sure of the units being printed? For instance, are the Depth readings in feet or meters? See Section 2.6.

- **Dissolved Oxygen readings seem wrong:**

- a) Is the sensor properly maintained and calibrated?
See Section 3.7.
- b) Are the multiprobe's polarizing batteries fresh? These batteries should be changed every six months. Note that these batteries, when installed, can shorten the life of the DO sensor. See Section 3.11.
- c) Does the multiprobe know whether you are working with a Standard or a LoFlow™ membrane? See Sections 2.6 and 3.7, and Appendix 1.

- **Has water leaked into your multiprobe?**

WARNING: EXCESS PRESSURE MAY BUILD UP INSIDE AN UNDERWATER HOUSING. THIS CAN CAUSE THE BOTTOM CAP, TOP CAP, SENSORS, OR OTHER REMOVABLE PARTS TO POP OUT OF THE HOUSING WITH ENOUGH FORCE TO CAUSE SERIOUS INJURY TO THE EYES, FACE, OR OTHER PARTS OF THE BODY.

WHENEVER YOU LOOSEN OR TIGHTEN SCREWS THAT HOLD REMOVABLE PARTS, ALWAYS POINT THE PARTS AWAY FROM YOUR BODY AND OTHER PEOPLE.

Follow the multiprobe disassembly instructions in Section 3.12.2.

WARNING: AS YOU REMOVE THE TWO ALLEN RETAINING SCREWS, BE SURE THAT THE BOTTOM CAP IS NOT POINTED AT ANYONE, SINCE THE INTERNAL PRESSURE CAUSED BY THE WATER LEAKAGE MAY BLOW THE BOTTOM CAP OUT OF THE H2O HOUSING. RINSE THE CIRCUIT BOARDS WITH DISTILLED WATER AND BLOW DRY WITH A HAIR DRYER. REPLACE THE WARM-UP BATTERIES (IF USED) AND REASSEMBLE.

Note: Please call Hydrolab Customer Service if you have a leakage problem, even if your multiprobe works well. Customer Service would like to help you prevent the recurrence of leaks.

2000



PART SEVEN: LOGGING

7.1 Parts of the Logging System

The DS3 Multiprobe comes in two forms: logging with Standard Memory (about 32,000 readings) and Extended Memory (about 70,000 readings). The internal battery pack is an option; it allows the multiprobe to log for short periods of time with a self-contained power supply. Alternatively, power can be furnished via the cable or via the submersible battery pack.

7.2 The Logging Menu

To enter the logging menu, simply access Logging from the Basic Menu (Section 2.3). Do this by hitting the Space Bar while in the SOM to get to the Basic Menu, and then type an L to get:

(D)ump,
(E)rase,
(S)etup,
S(t)atus,
(R)eview,
(A)nnotate,
St(o)re,
or (Escape or Ctrl X to cancel)
Select:

Typing a D will get you into the data dump (recovery) mode; typing an E will let you erase data files no longer needed; typing an S will let you set up a logging run(s); typing an R will let you review data files; typing an A will allow you to annotate the manual file; and, typing an O will store data to the Manual file.

7.3 Dumping (Recovering) Data from the Memory

7.3.1 Getting Started

To communicate with a PC, first boot your communications program on your PC, and set the PC for 1200 baud, 8 bit, no parity. Then connect your DS3 to your PC with either a calibration cable or an underwater cable and an interface cable. Connect an external battery (RBP-6AH or AUX-PC with your

own battery) to operate the DS3 and/or preserve internal battery (if internal battery option is installed). Now produce the Basic Menu by pressing the PC's space bar.

We want to work in the Logging menu. Type L to see:

(D)ump,
(E)rase,
(S)etup,
(f)atus,
(R)evue,
(A)nnotate,
(o)re,
or (Escape or Ctrl X to cancel)
Select:

Type D <CR> to access the data Dump (recovery) mode. You will see on the PC screen:

Power down probes during dump?
(Y)es
(N)o,
or (Escape or Ctrl X to cancel)
Select:

If your DS3 is using the internal battery pack, select Y (and press Enter) to turn the power to the probes off. This prolongs battery life (and speeds recovery). Next you will see a filled-in version of this chart:

###	Log File Name		Start		Stop		Interval
			MMDDYY	HHMMSS	MMDDYY	HHMMSS	HHMMSS
0	=>AUTOLOG<=	<=Enabled	010100	000000	123199	235959	010000
1							
2							
3							
4							
5	=>MANUAL<=		010100	000000	010100	000000	000000

Select Log File: _

Select the number of the file that you wish to dump, and push Enter, to see:

(P)rinter ready,
(S)preadsheet importable,
or (Escape or Ctrl X to cancel)
Select:

Select P if you wish your data to be dumped as "Printer ready". This format is used for disk archiving or word processing. Select S if you want your data dumped to a file that is pre-formatted for opening into a spreadsheet. Now you will get:

(S)etup variables and calibration,
(F)ollow variable and calibration changes,
(C)urrent variables and calibration,
or (Escape or Ctrl X to cancel)
Select:

These selections allow you to change the calibrations (and variable settings) upon which the data is based. Select S to have the data dumped using the calibrations/variables in effect at the time of Setup for that particular logging run. The Autolog file (File 0) always uses the calibrations in effect at the time that Autolog is enabled. The Manual File (File 5) always uses the calibrations in effect at the time the first data is entered with the Store and Annotate keys.

Select F to have the data dumped using the calibrations/variables Follow each particular reading was taken. For instance, if you recalibrated DO at noon on Tuesday (in the middle of a logging run), all the data printed for DO readings taken before noon on Tuesday would reflect the original DO calibration, and all the data printed for DO readings taken after noon on Tuesday would reflect the new DO calibration.

Similarly, select C to have the data dumped using the calibrations/variables Current at the time of the data dump. If you first dump data based on the calibration at the time of setup, and then dump the same data based on the calibration at the time of the data dump, you can compare the readings for an indication of calibration drift. (You can also correct certain kinds of mistakes, like improper initial setting of the cell block type, DO membrane type, etc., simply by re-dumping with those variables changed to the proper setting.)

7.3.2 *If You are Dumping as Printer Ready*

If you have selected Printer ready, after selecting S, F, or C, you see:

(N)o statistics,
(D)aily statistics,
(T)otal statistics,
(B)oth daily and total statistics,
or (Escape or Ctrl X to cancel)
Select:

Now you must decide what automatic statistical work is to be done (statistics are not available for spreadsheet file creation). The statistics involved are, for each parameter: the number of readings taken, the number of readings that were out of the parameter's measurement range, the minimum and maximum readings, the maximum rate of change between measurements for the parameter, and the mean and standard deviation for each parameter.

Select N to show No statistics on the printout; select D to calculate the statistics for each Day of the logging record; select T to calculate the Total statistics for the logging run as a whole; select B to give you Both daily and total statistics. (Note that calculation of statistics will increase the time it takes to dump a file.)

If you have specified Printer ready, you will see:

Activate printer and/or open capture file, then press any key to continue...

This means turn the printer on and hit any of the PC's keys to start the data flowing from the DS3 to the PC.

If you had selected the Autolog file to dump as "Printer ready" and with Setup Variables and Calibration, for example, you would see something like this:

Log File Name: => AUTOLOG <=
Setup Date (MMDDYY) : 060589
Setup Time (HHMMSS) : 175241
Starting Date (MMDDYY) : 010100
Starting Time (HHMMSS) : 000000
Stopping Date (MMDDYY) : 123199
Stopping Time (HHMMSS) : 235959
Interval Time (HHMMSS) : 010000

Warmup: Enable

=> Setup Variables and Calibration <=

Temperature: Centigrade

Specific Conductance/Resistivity: Specific Conductance,
mS/cm, Fresh, Autorange, Salinity, Temperature compensated

% Sat: 760

DO: No Flow, Salinity compensated

Depth/Level: Meters, Depth

Buzzer: Enable

Stirrer: Enable

Time HHMMSS	Temp deg C	pH units	Cond mS/cm	Salin ppt	DO %Sat	DO mg/l	Redox volts	Depth meters	Batt volts
Date (MMDDYY): 060589									
180000	25.02	4.01	1.001	0.0	97.2	8.00	0.006	0.0	12.7
190000	24.99	4.03	1.000	0.0	97.4	8.02	0.009	0.0	12.7
200000	24.99	4.03	1.000	0.0	97.4	8.02	0.011	0.0	12.7
210000	24.99	4.03	1.000	0.0	97.4	8.02	0.012	0.0	12.8
220000	25.03	4.01	1.000	0.0	97.1	7.99	0.008	0.0	12.7
230000	24.99	4.03	1.000	0.0	97.4	8.02	0.007	0.0	12.7
Date (MMDDYY): 060689									
000000	25.01	4.03	1.000	0.0	97.2	8.01	0.012	0.0	12.7
010000	25.01	4.02	0.999	0.0	97.2	8.01	0.000	0.0	12.7

and so on until the statistics were printed. You will then see the ending statement:

Recovery finished at MMDDYY HHMMSS

Deactivate printer and/or close capture file, then press any key to continue...

7.3.3 If You are Dumping as Spreadsheet Importable

Once you have selected S, F, or C (for your calibration/variables options, see Section 7.3.1) and hit Return, you will see:

Starting XMODEM Transfer ...

(Note that you were not asked any of the questions involving data statistics, since statistics are not available for spreadsheet imports.) You must now tell your communications program to proceed with an X-modem download. (If you are using Procomm, hit the "page down" key and select Option 1.) Then, when asked, type in, with the PC's keyboard, the name you wish to give the file containing your field data (say, TWINLAKE.DAT) and press Return. You will shortly see:

Transfer completed!

You can now close your communications program, open a spreadsheet, and then import this file into the spreadsheet. Your data will be preformatted for spreadsheet distribution, and all text will be quoted.

7.4 Erasing Files

Dumping a file does not erase that file; you must purposely erase a file to regain the use of the memory space occupied by that file. From the logging menu, type an E to get a file directory:

###	Log File Name	Start		Stop		Interval
		MMDDYY	HHMMSS	MMDDYY	HHMMSS	
0	=>AUTOLOG<=	<=Enabled		010100	000000	123199 235959 010000
1	Site 12F Town Lake slow	060989	123000	061689	170000	003000
2	Trout Tank Aeration Test	060989	080000	060889	103000	000130
3	Site 12F Town Lake fast	061589	020000	061589	143000	000500
5	=>MANUAL<=	010100	000000	010100	000000	000000

Select Log File: _

Type in the number of the file you wish to erase (from 0 to 5) to get:

WARNING: Data will be lost!

Are you sure you want to erase "file name"?

(Y)es,

(N)o,

or (Escape or Ctrl X to cancel)

Select:

Now type an N if you don't want to erase that file and wish to be returned to the logging menu. An Escape or Control X will also return you to the SOM. If you type a Y, you will see:

"file name" has been erased!

and you will be returned to the SOM.

7.5 Setting Up a Logging Run

Make sure that the status of the Buzzer, Stirrer, and enabled Parameters are correct before you set up a logging run; they cannot be changed later. Calibration and Variable settings can be changed later (see Section 7.3).

If you are in the logging menu, typing an S will cause these messages to appear:

Enter Log File Name:

You must type in the name of the logging run you are creating (32 characters maximum), followed by a carriage return, to get:

Enter Starting Date (MMDDYY):

You must now enter the date you wish the logging to commence. Enter six digits for the date, as in 051189 to start logging on May 11, 1989. Type a return and get:

Enter Starting Time (HHMMSS):

You must now enter the time you wish the logging to commence. Enter six digits for the time, as in 173500 to start logging at 5:35 PM. Type a return and get:

Enter Stopping Date (MMDDYY):

Now enter the date you wish logging to cease, just as you entered the starting date. Hit a return when finished to get:

Enter Stopping Time (HHMMSS):

Now enter the time you wish logging to cease, just as you entered the starting time. Hit a return when finished to get:

Enter Interval (HHMMSS):

Now enter the cycle time between logging scans. 001500 means that a logging scan will be made every 15 minutes between the start and stop times of the logging run. Hit the return key to get:

Enable warmup?

(Y)es

(N)o

or (Escape or Ctrl X to cancel)

Select:

Type a Y if you want an automatic, 120-second warmup time before each set of readings is made and then stored to memory. This is a good idea if you are not using the DO-pH-Redox polarizing batteries (see Section 3.11) or if you are using a stirrer. The stirrer comes on automatically as a logging scan begins, and then shuts off after the logging scan is safely sent to memory.) Type an N if you are using the DO-pH-Redox polarizing batteries, do not need a stirrer, or do not want the warmup for some other reason (for instance, to maximize available power supply). Even under No Warmup, the multiprobe comes on 30 seconds before a logging scan for warmup. If you press Escape or Control X, the entire logging setup will be aborted.

If you selected Y or N, the logging setup is now complete and you will be returned to the SOM.

You can check your work by accessing Status from the logging menu.

7.6 Status

Typing a T from the logging menu will cause a display similar to this:

###	Log File Name		Start		Stop		Interval
			MMDDYY	HHMMSS	MMDDYY	HHMMSS	HHMMSS
0	=>AUTOLOG<=	<=Enabled	010190	120000	123199	235959	010000
1	Lake Travis Site 7		010590	150000	010790	150000	001500
2	Lake Travis Site 4		010590	153000	011290	153000	001500
5	=>MANUAL<=		010100	000000	010100	000000	000000

==> Estimates only, see manual for details. <==

Status at 012990 164255

Memory: 84736 bytes left (2492 scans or 24922 rdgs w/current parameters)

DS3-IBP : 47% left

Status at 123199 235959

Memory : used up at 012990 165305

DS3-IBP : used up at 012990 201015

press any key to continue ...

This status report is designed to help you estimate how much memory is left for more logging, and how much life is left in your battery.

REMEMBER: the numbers in this report are estimates; the number of variables involved prevents exact answers. For instance, the internal battery pack (DS3-IBP) estimates assume you are operating Duracell® Copper-tops at room temperature. If you are using a lesser battery, or are operating at lower temperatures, your battery life will be reduced. To prevent data loss, always plan conservatively.

The first section shows you the name and number (Autolog is always file number zero; Manual is always file number five; and there are a maximum of four other files available) of each logging file. These files can be past logging runs, current logging runs, or logging runs that are set to happen in the future. Also shown are the programmed start, stop, and interval times for each run.

The second section shows the memory and battery status at the time of the report. In the example, there is enough memory left to store 24922 readings. Also shown is the amount of life left for the battery (100% means fully-charged) in use at the time of the report. The DS3-IBP refers to the internal battery pack and the RBP-6AH refers to Hydrolab's 12-volt, rechargeable battery pack.

Note that the battery status is only valid if the battery with which logging will be done is powering the unit at the time of the status report. Changing batteries after making the status report will change the expected battery life.

The third section shows that the batteries will last until the times shown, depending on the type of battery you are using.

Press any key on the key board to return to the SOM.

7.7 Review

The Review feature allows you to scan stored data without needing to dump the entire file. Press the Logging and Review keys to get:

###	Log File Name		Start		Stop		Interval
			MMDDYY	HHMMSS	MMDDYY	HHMMSS	HHMMSS
0	=>AUTOLOG<=	<=Enabled	010100	000000	123199	235959	010000
5	=>MANUAL<=		010100	000000	010100	000000	000000

Select Log File: _

Select the number of the file to be reviewed and press enter to see:

Starting location for review?

(B)eginning of file,

(E)nd of file,

(D)ate and time,

or (Escape or Ctrl X to cancel)

Select Beginning of file

Select B if you want the review to start at the beginning of the file selected. Select E to start at the end of the file (you can scroll backward through time). Select D to specify a date and time at which to start the review.

At this point, you will be prompted for key commands and receive a header:

Ctrl J to scroll down, Ctrl K to scroll up, Ctrl I for date,

Ctrl H to reselect location, or (Escape or Ctrl X to cancel)

Use the Ctrl K and Ctrl J key to go backward or forward in time, respectively. Press the Ctrl I key to show the date and time; press the Ctrl H key to select another location in the File. Data seen during Review is always based on the calibration in effect at the time the data was taken.

Press Escape or Ctrl X to exit review and return to the SOM.

7.8 Store

If you are, say, making a lake profile and have arrived at a set of stable readings for a particular station, select **Store** to save the current data (i.e, all parameter values, whether enabled or not) into the DS3's memory.

Since the data logged with **Store** does not follow a prescribed logging run, they are always entered into File 5, the Manual file.

7.9 Annotate

In the same way that **Store** saves readings, **Annotate** saves text. For instance, you might wish to enter a message such as "TWIN LAKES TRANSECT 4" just before you store some sets of readings from Twin Lakes into the Manual file (File 5) with **Store**. When File 5 is dumped, that message will be printed just before the Twin Lakes data is printed.

To make an annotation, select **Annotate** and type in your letters and/or numbers. Up to 49 characters can be entered as a single annotation; use more annotations if more text is needed.

7.10 Deployment

Once you have set up a logging run, simply put the multiprobe to sleep by disconnecting the interface cable. The multiprobe will wake up automatically when the logging run starts, and will continue to wake up and take data until the logging run is scheduled to stop, or until the power supply is depleted, or until the memory is full, whichever comes first. Deploy the multiprobe to the field as prescribed in PART FOUR: DEPLOYMENT.

7.11 Autolog

Autolog is an automatic logging routine that will help you avoid data loss. **Autolog**, when enabled through the **Variables** menu (Section 2.6.6), will record all parameters once each hour (**Autolog** always enables **Stirrer** and **Buzzer**) until you go back into the **Variables** menu and disable **Autolog**. (**Autolog** is disabled also by a dead battery or a full memory.)

An enabled Autolog can give you back-up data for situations in which the starting time or date, stopping time or date, or interval time has been specified incorrectly. Plus, if there is for some reason a reset of the multiprobe electronics, Autolog is set, by default, to be enabled. Thus, an accidental reset will not mean that all record of a logging run is lost.

You might find it easier to gather data with Autolog than to set up specific logging run. Be sure to allow enough memory space and battery capacity for Autolog operation (see Sections 7.13 and 7.6).

Note: Autolog is not enabled at the factory; you must enable it after receipt if you want the Autolog function.

7.12 Power Supplies for Logging

There are three ways to power a logging multiprobe. One is to simply leave the cable, interface cable, and battery connected to the multiprobe while it is logging. If this is inconvenient, you can use the one of the optional battery packs.

The internal battery pack uses a set of 10 "AA" batteries contained in the upper part of the multiprobe. If that is inconvenient or too small, you can use the submersible battery pack. This device screws onto the multiprobe and feeds power via the multiprobe's bulkhead connector. It is equipped with 12 "C" cells, providing about 7 amp-hours.

7.13 Changing the Batteries in the Internal Battery Pack

Once the voltage of the internal battery pack is too low for another logging run (the IBP is generally completely exhausted at 9 volts), the 10 "AA" batteries in the IBP must be changed. (Check your Status report, Section 7.6.)

First, clean the multiprobe all over with soapy water and a soft brush. After it is cleaned and thoroughly dried, remove the two hex-head Allen screws that hold the IBP in the multiprobe housing. Then, grasp the battery pack and with a slight twisting motion, pull it from the multiprobe tube. It is a tight fit, so you may wish to engage a helper. Once it is free of the housing, gently pull the wiring loose from the connector inside the housing.

Now turn the IBP over so that you are looking at the inside surface (i.e., not the bulkhead connector for the Cable). Remove the two large hex-head Allen screws that hold the battery pack together and remove and discard the spent batteries. Install 10 new batteries (we recommend Duracell® Coppertops, or the equivalent, for longest life. Do not use Lithium cells - their voltage is much too high). Pay close attention to the polarity-marking label, since one mistake can ruin a set of batteries.

REMEMBER: When installing the 10 "AA" batteries, make sure that no two adjacent batteries are pointed the same direction. The batteries should alternate polarities.

Reassemble the IBP (note that the lower plate can only fit one way). Now, if the IBP (especially its o-rings) and the housing are very clean and suitably-well greased, reattach the internal connector and re-install the IBP into the housing. Be sure to replace the two Allen screws that retain the battery pack in the housing.

7.14 Changing Batteries in the Submersible Battery Pack

When the multiprobe will no longer allow logging with the submersible battery pack, or when you think the battery voltage is too low to last for another field deployment (the SBP is generally completely exhausted at 9 volts), it is time to put 12 new alkaline-type "C" cells into the SBP. (Check your Status report, Section 7.6.) Duracell "coppertop" cells are recommended for their longer life.

First, unplug the SBP power connector from the multiprobe and unscrew the SBP from the multiprobe's bottom cap. (Don't leave the sensors unguarded; always attach either the storage cup or calibration cup to the multiprobe whenever the SBP is not in place.) Take the SBP over to the sink and scrub it all over with a vegetable brush and soapy water.

When it is cleaned and dried, remove the two Allen screws from the top cap (on the end of the SBP mounting the power connector). Grasp the white plastic coupler and use it to pull the top cap straight out of the housing. Be careful; don't throw the top cap across the room if it is unusually tight, since there are wires attached to the cap.

Wipe away any dirt or grit that may have lodged under or around the top cap, and be sure the o-rings and the surface upon which they seat are very clean. Lack of care in cleaning the o-rings will lead to flooding of the SBP. This can cause a premature end to a logging run and might make you buy a new SBP.

Replace all the spent batteries with new cells, making sure to observe the polarity markers on the battery clips. Check for any sign of battery leakage, terminal corrosion, or water leakage.

Now, after again making sure that everything in sight is spotlessly clean and that the o-rings and the o-ring seats have a light coat of the white silicone grease found in the maintenance kit, replace the top cap back into the SBP housing and replace the two Allen screws. There is no need to overtighten these screws; they just hold the assembly together and are not part of the seal.

7.15 Memory and Battery Limitations to Logging Runs

A logging run can be prematurely ended by filling up the memory too quickly, or by exhausting the power supply, be it a internal battery pack, submersible battery pack, or a cable-supplied power source.

The Standard Memory can hold about 32,000 readings. This means, for instance, that you can log all parameters, twice an hour, for about 60 days. The Extended Memory can hold about 70,000 readings.

If you are using the internal battery pack of 10 "AA" batteries, you can estimate your battery life by assuming a life of 2.1 amp-hours (with fully-charged Duracell Copper-tops). The submersible battery pack with 12 "C" batteries is approximately 7 amp-hours (with fully-charged Duracell Copper-tops).

Remember that the above battery-life statistics are for room-temperature operation; a battery's life is generally reduced by about 20% in 0°C operation.

(Most of this work is done automatically for you in the Status report, Section 7.6.)

See Appendix 4 for information on DS3 current drawn during operation modes.

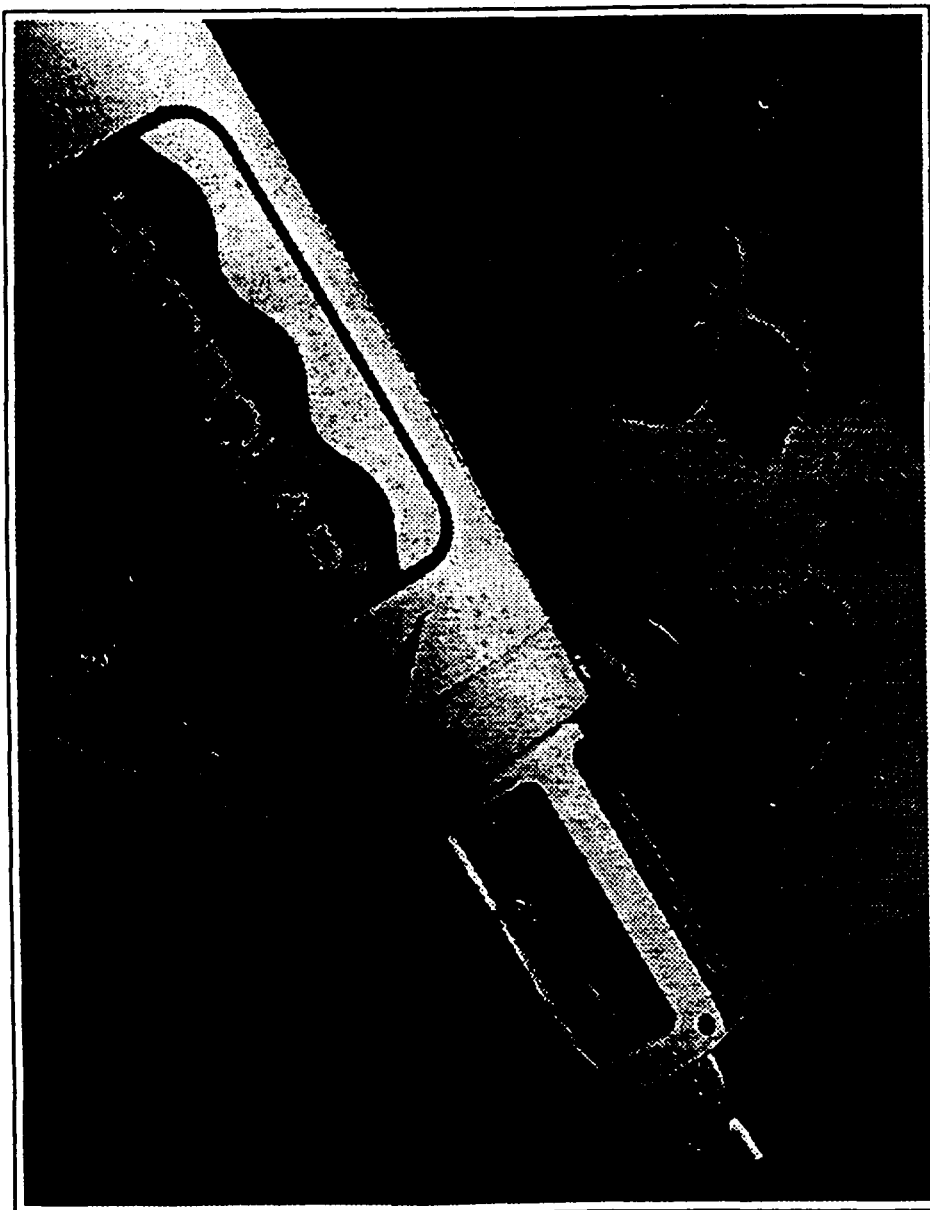
7.16 Multiprobe Warm-Up

Once the multiprobe is powered, by connection to a terminal or at the onset of a logging run, it takes a few seconds for the sensor readings to stabilize. The stabilization time depends on several factors, including the use of the DO-pH-Redox polarizing batteries (see Section 3.11) and whether or not you are measuring DO. If your sensors are continuously polarized (Section 3.11) and you are not using a stirrer, then the standard 30-second warm-up is satisfactory.

If your sensors are not continuously polarized, and you are measuring DO, you should likely select the 2-minute warm-up. This will allow the DO reading, whether you are using a stirrer or not, to stabilize. See Section 7.5 for information on activating the 2-minute warm-up.

Hydrolab Corporation
Multiparameter Water Quality Instrumentation

ORDERING GUIDE

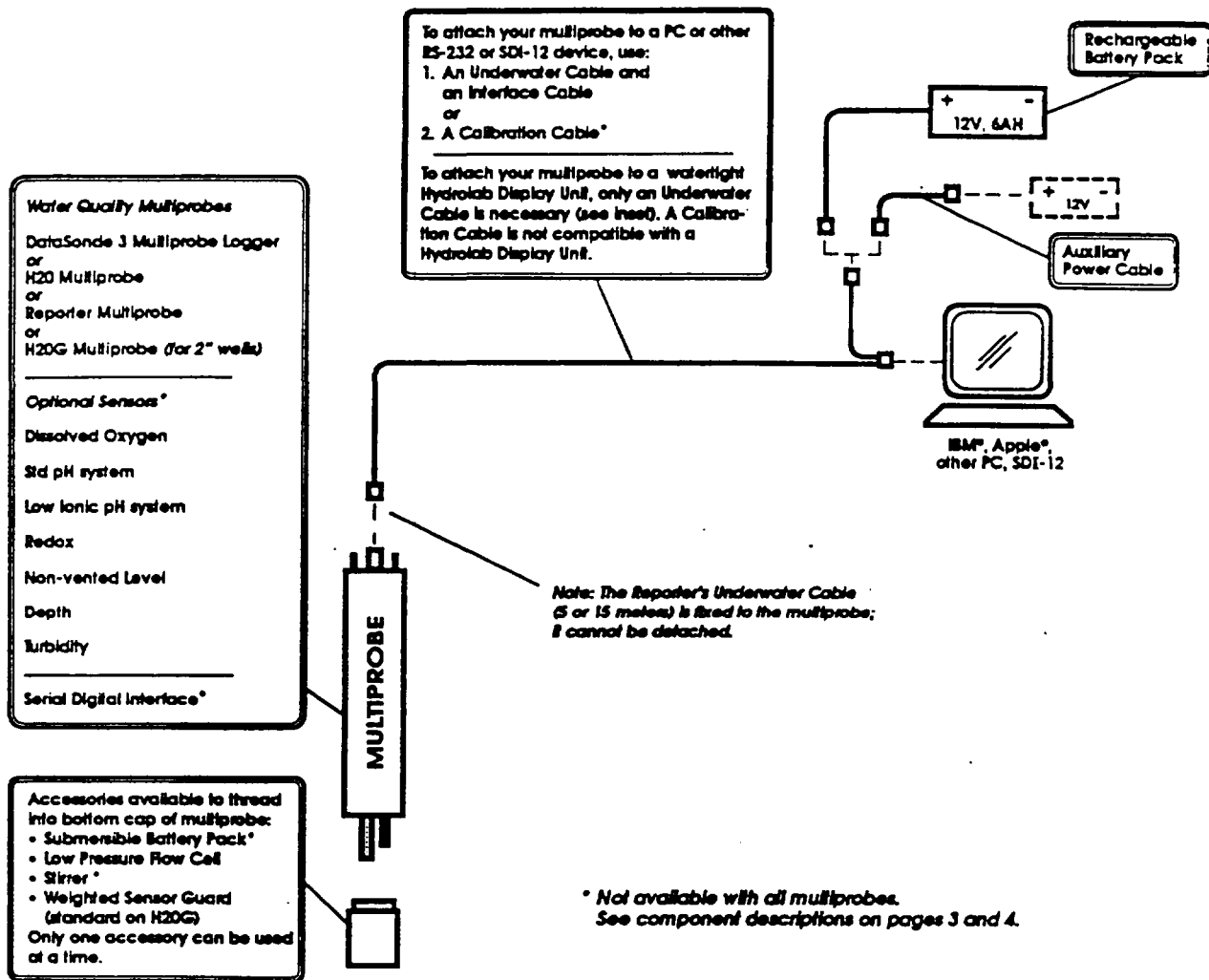


Helping Preserve Our World's Water Resources

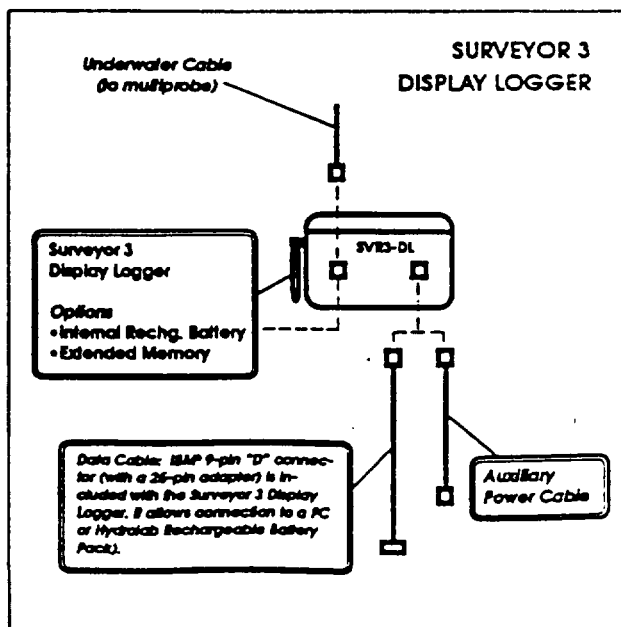
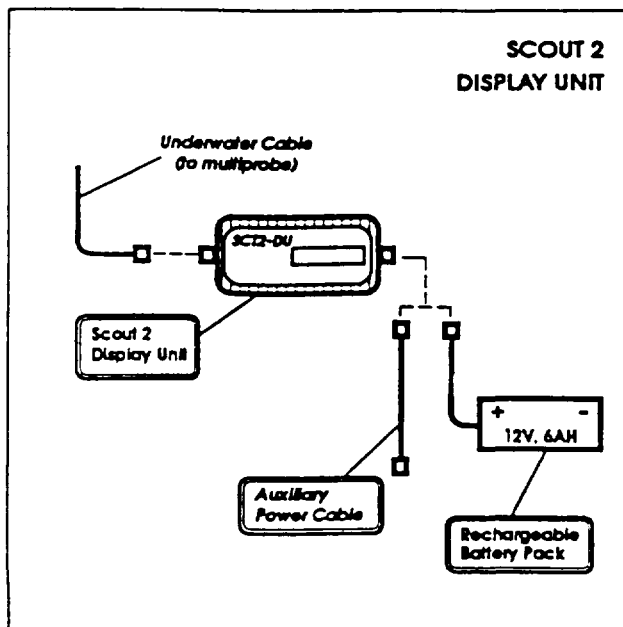
December 1993

COMPONENT CONFIGURATION

(This diagram does not show all components. Please consult the component descriptions on pages 3 and 4 as you make your selections.)



* Not available with all multiprobes.
 See component descriptions on pages 3 and 4.



COMPONENT DESCRIPTIONS

MULTIPROBES

Each multiprobe is constructed of an engineered plastic housing, 316 stainless steel hardware, and double o-ring seals. Each multiprobe includes an operating manual, calibration/maintenance kit, and storage cup.

H2O* MULTIPROBE

Our standard multiprobe. Use it with a Scout 2 Display Unit for profiling and spot-checking. Connect it to a Surveyor 3 Display Logger for unattended logging. Connect it to a PC for viewing and storing data. Collect data remotely while linked through modems or data loggers.

Includes measurement systems for temperature, specific conductance, conductivity, salinity, % saturation, resistivity, and total dissolved solids. Maximum immersion is 200 meters.

H2O Multiprobe Options (must be installed at factory):

- **PARAMETERS**...may choose from dissolved oxygen, standard pH, low ionic pH, redox (ORP), level, depth (100m or 200m), and turbidity
- **SDI-12**...Serial Digital Interface (requires an SDI interface cable)

H2O*G MULTIPROBE

This multiprobe was designed specifically for monitoring 2" groundwater wells. It serves as a complementary alternative to pump and purge sampling techniques. Same functionality as H2O.

Includes measurement systems for temperature, specific conductance, conductivity, salinity, % saturation, resistivity, and total dissolved solids. Maximum immersion is 150 meters.

H2O*G Multiprobe Options (must be installed at factory):

- **PARAMETERS**...may choose from dissolved oxygen, standard pH, redox (ORP), level, and depth
- **SDI-12**...Serial Digital Interface (requires SDI interface cable)

DATASONDE* 3 MULTIPROBE LOGGER

Our most versatile and feature-packed multiprobe. The DataSonde 3 combines all H2O multiprobe capabilities with an internal data logger. Able to store up to 27,200 readings (standard memory) with all parameters enabled.

Includes measurement systems for temperature, specific conductance, conductivity, salinity, % saturation, resistivity, and total dissolved solids. Maximum immersion is 150 meters.

DataSonde 3 Multiprobe Options (must be installed at factory):

- **PARAMETERS**...may choose from dissolved oxygen, standard pH, low ionic pH, redox (ORP), level, depth, and turbidity
- **SDI-12**...Serial Digital Interface is standard on the DataSonde 3 (requires an SDI interface cable)
- **EXTENDED MEMORY**...Increases the data storage capacity of the DataSonde 3 to approximately 59,700 readings with all parameters enabled.

- **INTERNAL BATTERY PACK**... This 10 "AA" alkaline battery cluster for the DataSonde 3 provides an estimated operating time, without a Stirrer, of 30 days, with all parameters and warm-up enabled, using a measurement interval of one hour. If using a Stirrer, the estimated operating time is reduced to approximately 20 days. Installing the Internal Battery Pack increases the overall length of the DataSonde 3 by 3.5 inches. Special note: A battery of one type or another is required for system operation; see other battery packs listed under ACCESSORIES.

REPORTER™ MULTIPROBE

A variant of H2O technology, the Reporter is designed for applications requiring unattended monitoring, and using an external data logger.

Includes measurement system for temperature. Maximum immersion is 15 meters.

Reporter Multiprobe Options (must be installed at factory):

- **PARAMETERS**...may choose specific conductance, dissolved oxygen and/or pH
- **SDI-12**...Serial Digital Interface (requires an SDI interface cable)
- **15 METER CABLE**...fixed multiprobe cable that may be ordered in lieu of the standard 5 meter cable
- **DEPLOYMENT KIT**...consists of a support ball and mounting hardware.

SENSOR DETAILS

All sensors are packaged in a single, compact multiprobe. Additional parameters may be added at a later date, though it is preferred to configure a multiprobe with all necessary sensors at the time of manufacture. If desired, ask for detailed parameter specifications from Hydrolab Sales.

DISSOLVED OXYGEN...Two measurement membranes are included. The Standard Membrane (normally used during profiling) provides fast response (less than 1 minute), but requires a Stirrer if sample velocities fall below 25 cm/sec. The LoFlow™ Membrane (normally used during unattended monitoring) operates without a Stirrer, even at low sample velocities, but with an increase in response time (approximately 5 minutes).

STANDARD pH...Appropriate for pH measurements in waters with specific conductance above 0.2 mS/cm.

LOW IONIC pH...Recommended if sample specific conductances can fall below 0.2 mS/cm. Either pH system can be installed, but not both. Not available on H2O*G or Reporter.

REDOX (ORP)...Requires that a pH system also be installed. Not available on Reporter.

NON-VENTED LEVEL...Has an operating range of 10m and must not be immersed deeper than 20m. Not available on Reporter.

DEPTH...Has an operating range of 100m and must not be immersed deeper than 150m. Either Depth or Level can be installed, but not both. Not available on Reporter.

200M DEPTH...Available on the H2O only. Has an operating range of 200m and must not be immersed deeper than 225m. Also includes a high-pressure multiprobe housing.

TURBIDITY...Uses nephelometric method (90° scatter). 0-1000 NTUs with multiple ranges. Based on ISO 7027. Not available on H2O*G or Reporter.

SDI-12

SERIAL DIGITAL INTERFACE...Allows a multiprobe to be connected to many 3rd party devices, including the U.S.G.S. "Basic Data Recorder" (BDR) and others that accept inputs from "smart" sensors conforming to the SDI-12 Serial Digital Communication Specification. Requires an SDI Interface Cable. Available on all multiprobes; standard on DataSonde 3.

CABLES

All of our cables consist of custom, high-pressure marine connectors and tough, urethane jackets.

UNDERWATER CABLES...An Underwater Cable connects a multiprobe to a display unit (or, with the help of an Interface Cable, to a PC or other device). Select according to required length. The Reporter underwater cable is not detachable and is only available in 5 or 15 meter lengths. When these multiprobes are equipped with the optional SDI-12 interface, the maximum immersion depth is 100 meters. Maximum immersion of Reporter multiprobes, with or without the SDI-12 interface, is 15 meters.

STIRRER CONNECTOR...Each cable that will employ a Stirrer requires a Stirrer Connector. If ordering more than one cable, designate each cable that is to have a Stirrer Connector installed. Not available with H2O*G cables.

INTERFACE CABLE...Required to connect an Underwater Cable directly to a PC or other RS-2 device. The cable's standard connector is an IBM® 9-pin D connector (with a 25-pin D adapter). Contact Hydrolab Sales for Interface Cables to other 3rd party devices.

SERIAL DIGITAL INTERFACE CABLE...Required to connect an Underwater Cable directly to an SDI-compatible device.

CALIBRATION CABLE...A short (3m) cable recommended for convenience during calibration setup, and data retrieval. Provides direct connection between multiprobe and PC or other RS-2 device, using an IBM® 9-pin D connector (with 25-pin D adapter). Can be used instead of

(continued)

(continued from previous page)

Underwater Cable/Interface Cable pair. Contact Hydrolab Sales for Calibration Cables to fit other 3rd party devices. *Not available on the Reporter.*

ACCESSORIES

WEIGHTED SENSOR GUARD... Threaded onto the sensor end of a DataSonde 3, H2O, or Reporter (when the Stirrer is not used) to provide negative buoyancy and sensor protection during deployment. *Note: A Weighted Sensor Guard is standard on the H2OG.*

STIRRER... Threaded onto the sensor end of the DataSonde 3, H2O, or Reporter to circulate the sample and to provide negative buoyancy and sensor protection during deployment. Requires Stirrer Connector on cable. *Not available on H2OG.*

LOW-PRESSURE FLOW CELL... Used when in-situ operation is not required and the sample is pumped past the sensors, during groundwater well purging, for example. **CAUTION:** User must not allow sample pressure to exceed 15psi.

STIRRER ADAPTER... Required when a Stirrer is connected directly to the DataSonde 3 during "off-line" (unattended) operation without an Underwater Cable. *Note: A Stirrer cannot be used while operating a Submersible Battery Pack or Flow Cell. Must have Internal Battery Pack, DS3-IBP, DataSonde 3 only.*

SUBMERSIBLE BATTERY PACK... 12 alkaline "C" cells provide an estimated operating time of 140 days, with all parameters and two-minute warm-up enabled, using a measurement interval of 1 hour. It is threaded onto the sensor end of the DataSonde 3 and provides negative buoyancy and sensor protection during deployment. (*Note: A Submersible Battery Pack cannot be used while operating a Stirrer or Flow Cell.*) DataSonde 3 only.

RECHARGEABLE BATTERY PACK... Provides the DataSonde 3 or H2O an estimated minimum 24 hours of continuous operation with a Stirrer installed. It can also be used to power the H2OG and Reporter. It is recommended for all operation in the laboratory. An international battery charger is also available.

AUXILIARY POWER CABLE... Required for use with customer-owned batteries. **CAUTION:** Do not connect to a charger, any line-powered device, or any source greater than 18 volts DC.

COMMUNICATION SOFTWARE... A communication software program is required for operating a multiprobe with a PC. We recommend and supply "PROCOMM PLUS" for IBM® compatibles, though other types may be used.

CUSTOM CARRYING CASE... Recommended to transport and store the DataSonde 3 or H2O Multiprobe and Hydrolab Accessories. *Not available for the H2OG multiprobe.*

ANALOG CONVERTER... The Hydrolab Analog Converter provides industry standard analog output for our multiprobes. The Analog Converter accepts the digital RS-232 output of the multiprobe and can be configured for voltage or current output that is compatible with commercial analog data collection devices. The Analog Converter includes one output card of your choice (expandable to eight), a controller card, and an operating manual. An LCD is optional for real-time display of water quality data.

DISPLAY UNITS

Our display units are compact, portable and lightweight. User-friendly software facilitates fast implementation of all calibration and display commands. Units can read and display six parameters simultaneously on an LCD. Both are powered by internal batteries for reliable field operation.

SCOUT® 2 DISPLAY... Our basic display unit. Just connect a multiprobe and press the "on" button. Includes an internal battery; a neckstrap leaves both hands free.

SURVEYOR® 3 DISPLAY LOGGER... This display logger can store up to 27,200 readings collected during spot-measurements or profiling. Or, it can be deployed with a multiprobe to perform unattended logging for weeks at a time.

- **INTERNAL RECHARGEABLE BATTERY...** Provides the Surveyor 3 with approximately 11 hours of continuous operation with Stirrer running (during profiling) or 14 days while recording all parameters at hourly intervals (in unattended logging mode and warm-up enabled). An international battery charger is also available.
- **EXTENDED MEMORY...** Increases data storage capacity of Surveyor 3 to approximately 59,700 readings with all parameters enabled.

H2O MULTIPROBE

components and pricing

	MODEL	DESCRIPTION
	H2O-BT	H2O[®] MULTIPROBE Includes an operating manual, calibration/maintenance kit, storage cup, measurement systems for temperature, specific conductance, salinity, resistivity, conductivity, and total dissolved solids.
MULTIPROBE OPTIONS	H2O-OX	Dissolved Oxygen
	H2O-SPH	Standard pH
	H2O-LPH	Low Ionic pH
	H2O-TRB	Turbidity
	H2O-RDX	Redox (ORP); requires pH
	H2O-NVL	Non-vented Level (range 0-10meters)
	H2O-DEP	Depth (range 0-100meters)
	H2O-DEP2	Depth (range 0-200meters)
	H2O-SDI	Serial Digital Interface (requires an HYD-SDIC cable)
CABLES		UNDERWATER CABLE LENGTHS
	H2O-005	5 meter (16 ft.)
	H2O-010	10 meter (33 ft.)
	H2O-025	25 meter (82 ft.)
	H2O-050	50 meter (165 ft.)
	H2O-075	75 meter (248 ft.)
	H2O-100	100 meter (330 ft.)
	H2O-ICX	Custom length: _____ meters x \$9.80/m+\$340
	HYD-SC	Stirrer Connector - factory installed on cable (required to operate Stirrer)
		INTERFACE CABLES
	HYD-IC	Connects Underwater Cable to IBM [®] 9-pin D connector (with a 25-pin D adapter)
	HYD-SDIC	Connects Underwater Cable to SDI-12 device (bare leads, coded)
		CALIBRATION CABLE
	HYD-CC	Connects multiprobe to IBM [®] 9-pin D connector (with a 25-pin D adapter) (3 meters)
ACCESSORIES	HYD-WSG	Weighted Sensor Guard
	HYD-STR	Stirrer, with Sensor Guard (requires a Stirrer Connector)
	HYD-LFC	Low-Pressure Flow Cell
	RBP-6AH	Rechargeable Battery Pack - U.S. (110VAC, 50-60Hz; with carrying case)
	RBP-6AHF	Rechargeable Battery Pack - International (220VAC, 50-60Hz; with carrying case)
	AUX-PC	Auxiliary Power Cable (for other 12V batteries only)
	COM-PCX	Communication Software (terminal emulation)
	HYD-CCC	Custom Carrying Case
	HYD-PAC	Analog Converter (customer-supplied 12VDC required) - Specify "voltage" or "current" for standard card and any additional cards - Additional Voltage or Current Cards; Optional LCD
DISPLAYS	SVR3-DL	SURVEYOR[®] 3 DISPLAY LOGGER (Includes an operating manual and Interface Cable)
	SVR3-M70	• Extended Memory (70K)
	SVR3-HRBP	• Internal Rechargeable Battery Pack - U.S. (110VAC, 50-60Hz; domestic charger) - To substitute an International charger (220VAC, 50-60Hz), write "INTL CHGR" on order
	SCT2-DU	SCOUT[®] 2 DISPLAY UNIT (Includes an operating manual and neckstrap)

Please refer to component descriptions on pages 3 and 4 before making order selections.

Prices and specifications are subject to change without notice.

Quotes are valid in U.S. dollars (for 30 days)

Payment Terms: Net 30 days; U.S. dollars

Shipping Terms: FREE ground delivery within the 48 states.

H20G MULTIPROBE

components and pricing

	MODEL	DESCRIPTION
	H20G-BT	STANDARD H20G MULTIPROBE Includes an operating manual, calibration/maintenance kit, storage cup, measurement systems for temperature, specific conductance, salinity, resistivity, conductivity, and total dissolved solids.
MULTIPROBE OPTIONS	H20G-OX	Dissolved Oxygen
	H20G-SPH	Standard pH
	H20G-RDX	Redox (ORP); requires pH
	H20G-NVL	Non-vented Level (range 0-10meters)
	H20G-DEP	Depth (range 0-100meters)
	H20G-SDI	Serial Digital Interface (requires HYD-SDIC cable)
CABLES		UNDERWATER CABLE LENGTHS
	H20G-005	5 meter (16 ft.)
	H20G-010	10 meter (33 ft.)
	H20G-025	25 meter (82 ft.)
	H20G-050	50 meter (165 ft.)
	H20G-075	75 meter (248 ft.)
	H20G-100	100 meter (330 ft.)
	H20G-ICX	Custom length: _____ meters x \$9.80/m+\$340
		INTERFACE CABLES
	HYD-IC	Connects Underwater Cable to IBM® 9-pin D connector (with a 25-pin D adapter)
	HYD-SDIC	Connects Underwater Cable to SDI-12 device (bare leads, coded)
		CALIBRATION CABLE
	HYD-CC	Connects multiprobe to IBM® 9-pin D connector (with a 25-pin D adapter) (3 meters)
ACCESSORIES	H20G-LFC	Low-Pressure Flow Cell
	RBP-6AH	Rechargeable Battery Pack - U.S. (110VAC, 50-60Hz; with carrying case)
	RBP-6AHF	Rechargeable Battery Pack - International (220VAC, 50-60Hz; with carrying case)
	AUX-PC	Auxiliary Power Cable (for other 12V batteries only)
	COM-PCX	Communication Software (terminal emulation)
	HYD-PAC	Analog Converter (customer-supplied 12VDC required) - Specify "voltage" or "current" for standard card and any additional cards - Additional Voltage or Current Cards; Optional LCD
DISPLAYS	SVR3-DL	SURVEYOR® 3 DISPLAY LOGGER (Includes an operating manual and Interface Cable)
	SVR3-M70	• Extended Memory (70K)
	SVR3-HRBP	• Internal Rechargeable Battery Pack - U.S. (110VAC, 50-60Hz; domestic charger) - To substitute an international charger (220VAC, 50-60Hz), write "INTL CHGR" on order
	SCT2-DU	SCOUT® 2 DISPLAY UNIT (Includes an operating manual and neckstrap)

Please refer to component descriptions on pages 3 and 4 before making order selections.

Prices and specifications are subject to change without notice.

Quotes are valid in U.S. dollars (for 30 days)

Payment Terms: Net 30 days; U.S. dollars

Shipping Terms: FREE ground delivery within the 48 states.

DATASONDE 3 MULTIPROBE LOGGER

components and pricing

	MODEL	DESCRIPTION
	DS3-BS	DATASONDE® 3 MULTIPROBE LOGGER Includes an operating manual, calibration/maintenance kit, storage cup, video, 35K memory, SDI-12 capability, measurement systems for temperature, specific conductance, salinity, resistivity, conductivity, and total dissolved solids
	DS3-M70	• Extended Memory (70K)
	DS3-IBP	• Internal Battery Pack
MULTIPROBE OPTIONS	DS3-OX	Dissolved Oxygen
	DS3-SPH	Standard pH
	DS3-LPH	Low Ionic pH
	DS3-RDX	Redox (ORP); requires pH
	DS3-NVL	Non-vented Level (range 0-10meters)
	DS3-DEP	Depth (range 0-100meters)
	DS3-TRB	Turbidity
CABLES		UNDERWATER CABLE LENGTHS
	DS3-005	5 meter (16 ft.)
	DS3-010	10 meter (33 ft.)
	DS3-025	25 meter (82 ft.)
	DS3-050	50 meter (165 ft.)
	DS3-075	75 meter (248 ft.)
	DS3-100	100 meter (330 ft.)
	DS3-ICX	Custom length: _____ meters x \$9.80/m+\$340
	HYD-SC	Stirrer Connector - factory installed on cable (required to operate H20-STR)
		INTERFACE CABLES
	HYD-IC	Connects Underwater Cable to IBM® 9-pin D connector (with a 25-pin D adapter)
	HYD-SDIC	Connects Underwater Cable to SDI-12 device (bare leads, coded)
		CALIBRATION CABLE
	HYD-CC	Connects multiprobe to IBM® 9-pin D connector (with a 25-pin D adapter) (3 meters)
ACCESSORIES	HYD-WSG	Weighted Sensor Guard
	HYD-STR	Stirrer, with Sensor Guard
	HYD-LFC	Low-Pressure Flow Cell
	DS3-SA	Stirrer Adapter
	DS3-SBP	Submersible Battery Pack
	RBP-6AH	Rechargeable Battery Pack - U.S. (110VAC, 50-60Hz; with carrying case)
	RBP-6AHF	Rechargeable Battery Pack - International (220VAC, 50-60Hz; with carrying case)
	AUX-PC	Auxiliary Power Cable (for other 12V batteries only)
	COM-PCX	Communication Software (terminal emulation)
	HYD-CCC	Custom Carrying Case
	HYD-PAC	Analog Converter (customer-supplied 12VDC required) - Specify "voltage" or "current" for standard card and any additional cards - Additional Voltage or Current Cards; Optional LCD
DISPLAYS	SVR3-DL	SURVEYOR® 3 DISPLAY LOGGER (Includes an operating manual and Interface Cable)
	SVR3-M70	• Extended Memory (70K)
	SVR3-HRBP	• Internal Rechargeable Battery Pack - U.S. (110VAC, 50-60Hz; domestic charger) - To substitute an international charger (220VAC, 50-60Hz), write "INTL CHGR" on order
	SCT2-DU	SCOUT® 2 DISPLAY UNIT (Includes an operating manual and neckstrap)

Please refer to component descriptions on pages 3 and 4 before making order selections.

Prices and specifications are subject to change without notice.

Quotes are valid in U.S. dollars (for 30 days)

Payment Terms: Net 30 days; U.S. dollars

Shipping Terms: FREE ground delivery within the 48 states.

REPORTER MULTIPROBE

components and pricing

	MODEL	DESCRIPTION
	REP-MP	REPORTER™ BASIC MULTIPROBE Includes an operating manual, calibration/maintenance kit, storage cup, fixed 5 meter (16 ft.) multiprobe cable, and a measurement system for temperature. May add any or all of the following parameters: REP-CND Specific Conductance REP-OX Dissolved Oxygen REP-SPH Standard pH REP-SDI Serial Digital Interface (requires HYD-SDIC cable)
	REP-VP	REPORTER™ MULTIPROBE VALUE PACK Includes all components of the Basic Multiprobe (with temperature) along with these options: REP-CND Specific Conductance REP-OX Dissolved Oxygen REP-SPH Standard pH REP-SDI Serial Digital Interface (requires HYD-SDIC cable)
MULTIPROBE OPTIONS	REP-015	Optional 15 meter (49 ft.) fixed multiprobe cable (in lieu of 5 meter cable.)
	REP-DPK	Deployment Kit (support ball)
	REP-SC	Stirrer Connector - factory installed on cable (including a Deployment Kit) (required to operate Stirrer)
ACCESSORIES	HYD-IC	Connects Multiprobe Cable to IBM® 9-pin D connector (with a 25-pin D adapter)
	HYD-SDIC	Connects Multiprobe Cable to SDI-12 device (bare leads, coded)
	HYD-WSG	Weighted Sensor Guard
	HYD-STR	Stirrer, with Sensor Guard (requires a Stirrer Connector)
	HYD-LFC	Low-Pressure Flow Cell
	RBP-6AH	Rechargeable Battery Pack - U.S. (110VAC, 50-60Hz; with carrying case)
	RBP-6AHF	Rechargeable Battery Pack - International (220VAC, 50-60Hz; with carrying case)
	AUX-PC	Auxiliary Power Cable (for other 12V batteries only)
	COM-PCX	Communication Software (terminal emulation)
	HYD-CCC	Custom Carrying Case
DISPLAYS	HYD-PAC	Analog Converter (customer-supplied 12VDC required) - Specify "voltage" or "current" for standard card and any additional cards - Additional Voltage or Current Cards: Optional LCD
	SVR3-DL	SURVEYOR® 3 DISPLAY LOGGER (Includes an operating manual and Interface Cable)
	SVR3-M70	• Extended Memory (70K)
	SVR3-IRBP	• Internal Rechargeable Battery Pack - U.S. (110VAC, 50-60Hz; domestic charger) - To substitute an International charger (220VAC, 50-60Hz), write "INTL CHGR" on order
	SCT2-DU	SCOUT® 2 DISPLAY UNIT (Includes an operating manual and neckstrap)

Please refer to component descriptions on pages 3 and 4 before making order selections.

Prices and specifications are subject to change without notice.

Quotes are valid in U.S. dollars (for 30 days)

Payment Terms: Net 30 days; U.S. dollars

Shipping Terms: FREE ground delivery within the 48 states.

SERVICE and LIMITED 2-YEAR WARRANTY

LIMITED 2-YEAR WARRANTY

Following is a statement of Hydrolab's warranty and service policy, effective January 1, 1991, which applies specifically to the DataSonde® 3 Multiprobe Logger, the H2O® Multiprobe, H2O®G Multiprobe, Reporter™ Multiprobe, the Surveyor® 3 Display Logger, and the Scout® 2 Display Unit, and all Hydrolab instruments introduced to market after January 1, 1991, unless specifically excluded in the warranty statement. This warranty specifically excludes batteries of any type. This warranty supersedes any and all warranties, for the above products, of an earlier date.

What We Will Do

All new Hydrolab products listed above are warranted by Hydrolab against defects in materials and workmanship for two years from date of invoice. During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective provided that you return the product, shipping prepaid, to the Hydrolab Service Department. Hydrolab's liability and obligations in connection with any defects in materials and workmanship are expressly limited to repair or replacement and your sole and exclusive remedy in the event of such defects shall be repair or replacement.

What Is Not Covered

In addition to batteries, this warranty shall not apply to products or parts thereof which may be used or connected to Hydrolab equipment but which are not manufactured by Hydrolab. Our obligation to repair or replace dissolved oxygen sensors does not apply to those that have been consumed through normal use.

This warranty shall not apply to products or parts thereof which have been altered or repaired outside of a Hydrolab factory or other authorized service center, or products damaged by improper installation or application, or subjected to misuse, abuse, neglect or accident.

THIS WARRANTY IS EXPRESSLY MADE BY HYDROLAB AND ACCEPTED BY PURCHASER IN LIEU OF ALL OTHER WARRANTIES. HYDROLAB EXPRESSLY DISCLAIMS ALL OTHER WARRANTIES, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, WHETHER WRITTEN OR ORAL, EXPRESS OR IMPLIED, OR STATUTORY. HYDROLAB NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR IT ANY OTHER LIABILITIES IN CONNECTION WITH ANY PRODUCTS.

Hydrolab's obligations under this warranty are conditional upon its receiving prompt written notice of claimed defects within the warranty period and its obligations are expressly limited to repair or replacement as stated above.

Hydrolab shall not be liable for any contingent, incidental, or consequential damage or expense incurred by you due to partial or complete inoperability of its products for any reason whatsoever or due to any inaccurate information generated by its products. Hydrolab's obligations and your remedies are limited as described above.

Products are sold on the basis of specifications applicable at the time of sale. Hydrolab Corp. shall have no obligation to modify or update products once sold.

Warranty Information

If you have any questions concerning this warranty, please call 800-949-3766 or 512-255-8841.

SERVICE and SHIPPING

How to Obtain Repair Service

1) Contact the Hydrolab Service Department by telephone, FAX, or letter at the following address in order to obtain a Returned Goods Authorization (RGA No.).

HYDROLAB CORPORATION
SERVICE DEPARTMENT
12921 BURNET ROAD AUSTIN, TX 78727 (USA)
TELEPHONE: 800-949-3766 or 512-255-8841
FAX: (512) 255-3106

2) Should you be advised by the Service Department to return an item, please adhere to the following shipping instructions to expedite its transportation to and from Hydrolab and to minimize its repair time at Hydrolab.

Shipping Instructions

1) Carefully pack your equipment in its original shipping case (or other protective package) to avoid in-transit damage. Such damage is not cov-

ered by warranty and we suggest that you insure the shipment to the Hydrolab Service Department. We also recommend that the entire instrument, including the battery pack and charger (when applicable), be returned unless a particular faulty component is clearly demonstrated.

2) Send the instrument and a completed SERVICE MEMORANDUM** to the address shown on the Service Memorandum.

Remember to include a sales invoice or other proof of purchase with your instrument. Whether the unit is under warranty or not, it is your responsibility to pay shipping charges for delivery to the Hydrolab Service Department.

Repair Policy

You may have your instrument repaired at the Hydrolab Service Department any time it needs service, whether it is in warranty or not. There is a charge for repairs after the 2-year warranty period.

Hydrolab instruments are normally repaired and shipped, transportation paid via UPS, within 10 working days of receipt at the Hydrolab Service Department.

* Returned Goods Authorization (RGA No.)

A Returned Goods Authorization (RGA No.) is provided by the Service Department upon request. The RGA No., assigned by the Service Department must be shown on the address label of each carton and in the space provided on the SERVICE MEMORANDUM. Any correspondence related to the equipment returned for repair must reference the (RGA No.).

** Service Memorandum

For your convenience, several copies of the SERVICE MEMORANDUM are included in your Operating Manual. One must be completed (with RGA No.) and included with any goods returned for service.

Call for more assistance: 800-949-3766

HYDROLAB CORPORATION
P.O. Box 50116 / Austin, Texas / 78763
800-949-3766 or 512-255-8841 / FAX 512-255-3106



R.G.A. No. _____

Date Shipped to Hydrolab _____



SERVICE MEMORANDUM

The following information is requested in order to process your order for warranty or non-warranty service. Please include this form, fully completed, with your return shipment.

Customer Contact Name _____

Customer Phone Number _____

Address for return
shipment of
repaired equipment

Zip

Address for billing _____
(or purchase authority) _____
for repair charges _____
not covered by warranty _____

Zip

WARRANTY INFORMATION – please check the appropriate box and furnish requested materials:

- ☐ Sales Warranty Attach copy of Invoice or Proof-of-Purchase
- ☐ Service Warranty Attach copy of previous R.G.A.
- ☐ Non-Warranty Method of payment:
- ☐ VISA/MC ☐ P.O. No. _____
- ☐ Other _____

SHIPPING INSTRUCTIONS – Please refer to the Instructions given under SERVICE AND WARRANTY (found in the back of your Instrument Operating Manual) before packaging your Instrument for shipment to Hydrolab.

Note: Please install dummy plugs and fill storage cups about 2/3 full of water prior to packaging.

Address each carton to:

**HYDROLAB CORPORATION
SERVICE DEPARTMENT
12921 BURNET ROAD
AUSTIN, TX 78727 U.S.A.**

Please clearly mark each box with: R.G.A. No. _____
Carton # _____ of _____

Please describe equipment problem on the reverse side of this memorandum.

		
Solid black	Diagonal line	Open

Model No. and Description

Serial No.

[illegible]

Description of Problem(s) or Explanation

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Date Shipped to Hydrolab _____



10

Serial No.

[illegible]

Description of Problem(s) or Explanation

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There is no handwriting or other markings on the paper.

R.G.A. No. _____

Date Shipped to Hydrolab _____



SERVICE MEMORANDUM

The following information is requested in order to process your order for warranty or non-warranty service. Please include this form, fully completed, with your return shipment.

Customer Contact Name _____

Customer Phone Number _____

Address for return
shipment of
repaired equipment

City

State

Zip

Address for billing _____
(or purchase authority) _____
for repair charges _____
not covered by warranty _____

City

State

Zip

WARRANTY INFORMATION – please check the appropriate box and furnish requested materials:

- ☐ Sales Warranty Attach copy of Invoice or Proof-of-Purchase
- ☐ Service Warranty Attach copy of previous R.G.A.
- ☐ Non-Warranty Method of payment:
- ☐ VISA/MC ☐ P.O. No. _____
- ☐ Other _____

SHIPPING INSTRUCTIONS – Please refer to the instructions given under SERVICE AND WARRANTY (found in the back of your Instrument Operating Manual) before packaging your instrument for shipment to Hydrolab.

Note: Please install dummy plugs and fill storage cups about 2/3 full of water prior to packaging.

Address each carton to:

**HYDROLAB CORPORATION
SERVICE DEPARTMENT
12921 BURNET ROAD
AUSTIN, TX 78727 U.S.A.**

Please clearly mark each box with: R.G.A. No. _____
Carton # _____ of _____

Please describe equipment problem on the reverse side of this memorandum.

HYDROLAB CORPORATION P.O. Box 50116 • Austin, Texas 78763 • USA
Telephone (512) 255-8841 • FAX (512) 255-3106

I 1

[illegible][illegible]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There is no handwriting or other markings on the paper.

APPENDIX 1

Dissolved Oxygen

Appendix 1

DISSOLVED OXYGEN:

SATURATION VALUES and SENSOR TYPES

A1.1 DO Saturation Values

Here is a listing of the dissolved oxygen saturation values used by Hydrolab water quality multiprobes when performing an air calibration of the DO system. The source of these values is an algorithm given in Measurement of Dissolved Oxygen, Hitchman, 1978. Included for comparison are saturation values from the 1971 and 1985 editions of Standard Methods for the Examination of Water and Wastewater. Each value is in milligrams per liter of zero chlorinity water, with first the temperature noted in degrees Centigrade.

	Hitchman	1985 SM	1971 SM
T°C	milligrams dissolved oxygen per liter water at one atmosphere		
0	14.57	14.621	14.6
1	14.17	14.216	14.2
2	13.79	13.829	13.8
3	13.43	13.460	13.5
4	13.08	13.107	13.1
5	12.74	12.770	12.8
6	12.42	12.447	12.5
7	12.11	12.139	12.2
8	11.81	11.843	11.9
9	11.53	11.559	11.6
10	11.26	11.288	11.3
11	10.99	11.027	11.1
12	10.74	10.777	10.8
13	10.50	10.537	10.6
14	10.27	10.306	10.4
15	10.05	10.084	10.2
16	9.83	9.870	10.0
17	9.63	9.665	9.7
18	9.43	9.467	9.5
19	9.24	9.276	9.4
20	9.06	9.092	9.2
21	8.88	8.915	9.0
22	8.71	8.743	8.8
23	8.55	8.578	8.7
24	8.39	8.418	8.5

(continued)

(continued)

T°C	Hitchman milligrams dissolved oxygen per liter water at one atmosphere	1985 SM	1971 SM
25	8.24	8.263	8.4
26	8.09	8.113	8.2
27	7.95	7.968	8.1
28	7.81	7.827	7.9
29	7.68	7.691	7.8
30	7.55	7.559	7.6
31	7.42	7.430	7.5
32	7.30	7.305	7.4
33	7.18	7.183	7.3
34	7.07	7.065	7.2
35	6.95	6.950	7.1
36	6.84	6.837	7.0
37	6.73	6.727	6.9
38	6.63	6.620	6.8
39	6.52	6.515	6.7
40	6.42	6.412	6.6
41	6.32	6.312	6.5
42	6.22	6.213	6.4
43	6.13	6.116	6.3
44	6.03	6.021	6.2
45	5.94	5.927	6.1
46		5.835	6.0
47		5.744	5.9
48		5.654	5.8
49		5.565	5.7
50		5.477	5.6

Note that these values are for the standard atmospheric pressure of 760 mm Hg. Linear interpolation will provide a reasonable estimate for saturation values of non-whole number temperatures.

See Part Five of the Operating Manual for information on the effect of barometric pressure on DO calibration and readings.

A1.2 LoFlow™ and Standard Membranes

The Standard Membrane (1-mil Teflon™) allows fast, accurate DO measurements in situations where fouling is not a problem and adequate sample flow (greater than about one foot per second) is assured. The LoFlow Membrane (patent pending) trades a little accuracy and response speed for greatly reduced sensitivity to flow and fouling. The LoFlow Membrane is suitable for flows down to about one mil per second.

Best of all, the LoFlow Membrane allows Hydrolab multiprobes to work in either fast-flowing clean waters, or waters where fouling and low or variable flow exist, because a single DO sensor can accommodate the Standard Membrane (1-mil Teflon) or the LoFlow Membrane. To change between the two types of membranes, simply change the membrane (both membrane types are found in the Maintenance Kit), notify the software of the change, and recalibrate.

Software notification is simple: access the Variables menu and select O (o, not zero) for Dissolved Oxygen; you will then be asked to specify S or L. Type an S if you have installed the Standard Membrane; an L if you are using the LoFlow Membrane. Then type an S (meaning you want your DO readings corrected for Salinity) or a U (meaning that you want your DO readings Uncorrected for salinity). You will then be returned to the SOM.

The LoFlow Membrane is a special, low-permeability polymer that reduces the oxygen passage across the membrane (into the sensor) required for a stable reading. It is thus less affected by variations in sample flow and membrane foulants than is the high-permeability Standard Membrane.

The LoFlow Membrane's error due to flow is about -6%, for flows above about one inch per minute. To optimize this error, each reading for the LoFlow Membrane sensor is automatically raised by 2.5%. You will notice this at calibration when the % Saturation reading is set to 102.5%, instead of the expected 100%.

Laboratory tests have shown that fouling that reduces the reading of a Standard Membrane by 20% has no effect on the readings of a sensor equipped with a LoFlow Membrane.

The software that incorporates the operation of the LoFlow Membrane also accommodates a new feature of interest to those measuring DO. If you access the Calibrate menu, and then you access O (for Dissolved Oxygen), you will be asked to state not one, but two standards. The answer to the first Std: "question" is the barometric pressure; type it in as mm of Hg and hit the return key. In answer to the second Std: "question", type in the DO reading you want your calibration to match. For instance, if you had a Winkler reading of 7.11 mg/l and you wanted to calibrate your multiprobe accordingly, you would type in 7.11 and hit the return key. Your multiprobe would then match the result of your Winkler determination.

This is an alternative to the other method for calibrating DO, as explained in Part Three of the Operating Manual, whereby you access % (for % Saturation) and type in a single Std: answer: the barometric pressure. The calibration is then set as the saturation value for the pressure you specified, and the ambient temperature as measured by the multiprobe.

Please read the paper included in the back of this manual (Application Note #105) comparing the LoFlow Membrane with the Standard Membrane and the Recessed Cathode sensor.

APPENDIX 3

Application Notes



Application Note #101: Dissolved Oxygen Sensor Life

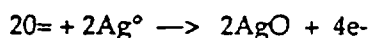
Q: How long will my Hydrolab dissolved oxygen sensor operate?

A: In Hydrolab's dissolved oxygen sensor, a gold cathode and a silver anode are connected by a potassium chloride (KCl) electrolyte. This electrolyte is contained by a membrane permeable to gases, particularly oxygen. When a small voltage is applied between the cathode and the anode, an electric current (electrons, e^-) is generated as oxygen gas (O_2) dissolved in the electrolyte is ionized (to $O=$) at the cathode and then "consumed" by the silver (Ag) anode:

general cathode reaction:



general anode reaction:



When the membrane is in contact with a sample, normally air or water, the electric current is proportional to the dissolved oxygen concentration of the sample. Hydrolab measures the electric current, correct for the temperature effect on the permeability of the membrane to oxygen, the temperature and salinity effects on the solubility of oxygen in water, and then scales the reading according to your calibration.

Note that all of the oxygen gas ionized at the cathode is consumed by the silver anode. As a result, all the silver of the anode is eventually converted to silver oxide, and the above reactions will no longer proceed. When this happens, the sensor will read so low that it will not calibrate, and so must be replaced.

The normal consumption of the anode, like the discharge of a battery, is a fact of chemistry. The sensor operates only because oxygen is ionized at the cathode and consumed by the anode, but only a certain amount of oxygen can be accommodated by the anode.

If your application is constant, unattended monitoring of highly-oxygenated waters, your sensor may well

last less than a year. If your application is a weekly field trip during which the sensor is only operated for a few hours, your sensor will likely last five years or more.

Here are a few tips on extending the life of your dissolved oxygen sensor:

- If you are profiling, turn the instrument off between measurement sites.
- Use the Polarizing Batteries (see Chapter Three of your H20⁺, H20⁺C, or DataSonde⁺3 Operating Manual) only when necessary. And, either remove the Polarizing Batteries or remove the sensor electrolyte when the instrument is not going to be used for an extended period.
- If you are doing unattended monitoring with Warmup enabled and no Polarizing Batteries installed, use the maximum prudent logging interval. Don't take a reading every 15 minutes if a reading every 30 minutes is sufficient.
- If you are doing unattended monitoring with the Polarizing Batteries installed and do not require the very fast, very accurate readings provided by the Standard Membrane with a Stirrer, use the LoFlowTM Membrane. Less oxygen passes through this membrane, so sensor life is extended.
- Change the sensor electrolyte frequently, every two weeks if possible.
- Don't leave the instrument on while the sensor is exposed to air except when making air calibrations.

Following these steps will lengthen the service life of your Hydrolab dissolved oxygen sensor and maximize the reliability of your water quality data.

For further information, please contact Hydrolab Customer Service at 1-800-949-3766.



The Problem

Many investigators have noticed errors as large as one pH unit when measuring the pH of waters under 200 micromhos/cm, even though their pH meters were successfully calibrated with standard (i.e., high ionic strength) buffers.

The situation gets worse with decreasing sample conductivity and temperature, and with increasing pressure, flow, and time between calibrations.

Most measurement circuitry and pH sensors operate normally in dilute samples. However, poor design or maintenance procedures can cause unstable potentials in the reference electrode junction. The usual result is too-low pH readings in acidic waters.

The Solution

The solution to the problem of pH measurement in waters of low ionic strength is in two parts: hardware and procedure.

Hardware: The porous Teflon™ junction of Hydrolab's standard reference electrode may not be as stable, over a period of, say, five days, as the optional LISREF (Beckman® Red Label Lazaran™) reference electrode. The LISREF has been tested extensively by Hydrolab and many customers, and found to perform well.

It is Hydrolab's recommendation that anyone making field pH measurements of below-200 μ mho waters use the LISREF reference electrode.

Procedure: It has been shown both in theory and in practice that a pH system cannot be assumed to make accurate measurements of anything but solutions whose ionic strength is not greatly different from that of the calibrating buffers. Errors as high as one pH unit have been produced in "calibrated" pH meters that have not been checked (after calibration) with a solution approximating the ionic strength (and pH) of the anticipated sample.

It is Hydrolab's recommendation that a pH system be calibrated with two conventional buffers and then checkpointed, before and after measurements, with a dilute standard. Orion® makes dilute buffers for this purpose.

It has also been demonstrated that some types of reference electrodes have a pressure-induced error of up to 0.5 pH unit. This error may show little instability or hysteresis with depth and so cannot be distinguished from legitimate pH readings. A pH system should be checked for pressure insensitivity if it is to be used at a depth of more than a few inches. This can be accomplished by placing the sensors and a dilute standard in a plastic bag. The assembly is then lowered through the water column to the desired depth; any changes in the pH reading are attributable to pressure effects (provided a large change in temperature has not occurred).

It is also strongly advised that the pH system be checked for errors in cold and flowing waters, as opposed to the warm, still solutions used for calibration; that the reference electrode be kept clean and soaking in a solution approximating its filling solution whenever the electrode is not in use; that field samples be grabbed, carefully transported to a laboratory pH meter (calibrated and tested in the same manner as the field unit, except for the pressure test), and checked for correlation with field readings.

Summary

A prudent investigator working with conductivities less than 200 micromhos/cm will employ Hydrolab's LISREF reference electrode. He will, at minimum, check his buffer calibration with a dilute solution of known, pertinent pH, and use this same solution to run a depth profile as a pressure sensitivity test.



Application Note #103: Procomm Plus™ Instructions

This guide will help you set-up and use your Hydrolab instrument with the PROCOMM PLUS™ Communications Software. Before proceeding, verify that you have the following:

- a. IBM® PC (or compatible) computer,
- b. RS-232 communication port,
- c. Adapter cable (In most cases, a DB25F to DB25M will suffice. Please check your individual computer COMM/Serial port; pin gender may differ.), and,
- d. Hydrolab instrument

Instructions to User

1. Plug the PC (or compatible) into its power source (also any Hydrolab equipment that requires external power).
2. Insert DOS (version 2.0 or later) in drive A. (If you have a hard disk, check drive C for version 2.0 or higher.)

3. Turn on the PC.

• Note: Remember to make back-up copies of PROCOMM PLUS. Do not use original floppies for normal use.

4. Install PROCOMM PLUS on your hard disk or to floppies as instructed in your PROCOMM PLUS manual.

5. **Important:** Read all the literature included in the PROCOMM PLUS manual to learn how PROCOMM PLUS works.

6. Type: PCPLUS (return). After PROCOMM PLUS and the copyright notice appear on the screen, press any key to enter the terminal mode.

7. Read the Hydrolab manual to learn how to establish communications. Either follow the Hydrolab procedures to recover data, calibrate, or program the interface, or press ALT-X to gracefully end the conversation and exit the program back to DOS.

8. Turn on Hydrolab instrument (if necessary).

9. Connect Hydrolab instrument to COMM/Serial port using the adapter cable. (In some cases, the Hydrolab terminal cable will connect directly to the COMM/Serial port.)

10. If the Hydrolab copyright and software version did not appear on the screen after several attempts, go to the troubleshooting section below.

Troubleshooting

1. **POWER.** Make sure all batteries are in good working order.

2. **CONNECTIONS.** Make sure all connections that need to be made are made correctly.

3. **PROCEDURE.** Make sure you follow the steps in "Instructions to User".

4. **PROGRAM.** Make sure PROCOMM PLUS comes to life on your computer. You must see the copyright notice from the publisher of PROCOMM PLUS and enter the terminal mode.

5. **DEFAULTS.**

• Verify that the correct COMM port is selected and the current settings match the Hydrolab instrument being used by selecting the ALT-P menu. Default settings for the Hydrolab H20®, H20®G and DataSonde® 3 Multiprobes, and Surveyor® 3 Display Logger are 1200 baud, no parity, 8 data bits, and 1 stop bit.

• Verify the correct terminal options by selecting ALT-S, then "terminal options", then "general options" to select the proper menu and review the following settings:

Terminal emulation – ANSI

Duplex – FULL

(XON/XOFF) – ON

BS translation – NONDESTRUCTIVE.

To return to the terminal mode, press the "escape" key twice and you will be given the option to save the settings permanently, or only for the current session.

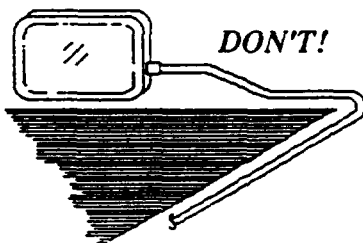
We want you to consider the multiprobe cable to be an **important** component of your water quality monitoring system. It serves two functions:

- 1) it is the means by which you raise, lower or deploy the multiprobe;
- 2) it provides the electrical connection by which battery power and data signals are transmitted between the multiprobe and the display.

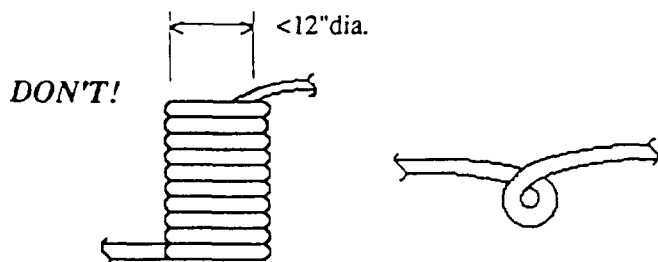
It has been engineered to be light-weight, portable, tough and durable in a sometimes hostile workplace. It is unimposing enough with its easy flexibility and nice blue color, but it is the part of your system that will be subject to the most abuse, no matter how you handle it. Observing a few precautions will pay dividends.

Here are the DON'Ts for electromechanical cables:

• **NO SHARP BENDS...** Don't run the cable over the gunwale, sheave, or pulley with less than a 6-inch radius, or knot the cable to maintain service depth.

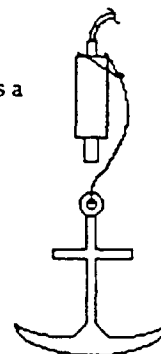


• **NO KINKS...** Don't allow kinks to form during handling or store in coils with less than a 6" radius (12" diameter).



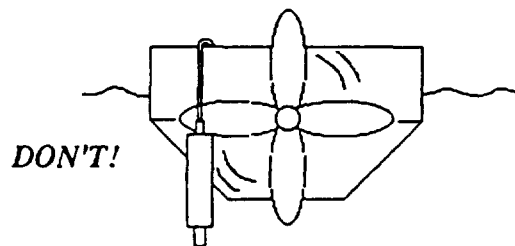
• **NO HEAVY WEIGHTS...**

Don't attach a too-heavy weight as a sinking aid. About 10 lbs. max., attached with 25 lb. test fishing leader. (If you need more weight, use a wire line to support the multiprobe.) Be certain to grasp the multiprobe by the "V"-shaped bail when placing it in and removing it from the water.



DON'T!

• **NO BOAT PROPS...**



Short cables usually present few problems in handling; a loosely coiled cable of 5 or 6 turns is about it. It's not heavy and it takes up little space in your boat or truck. Long cables are another story and some means of storage, transportation and boat handling is generally required.

For very long cables, a battery-powered or manually-cranked reel with electrical slip-rings may be a welcome accessory but they are heavy, very expensive and take up premium deck space. Lighter weight reels without slip-rings are available to simplify the raising and lowering of the multiprobe, but the instrument must be disconnected during spooling. Another method, sometimes employed, is to mount the reel horizontally in the fashion of a "lazy susan" with the instrument and battery installed in the hub. Still, portability and deck space are a concern.

There are other methods, including hose reels, but in our 30 years of building multi-parameter water quality monitoring systems we have seen only one device that seems to answer most of the requirements for instrument storage, transportation and cable handling in boat or

truck. We are indebted to field technicians at TVA in Chattanooga for re-inventing and providing a measure of scientific dignity to the common "trash can".

An industrial-grade plastic trash can, of appropriate size to accommodate your cable, transmitter, circulator, display unit and battery, may be the ideal means of handling your Hydrolab instrument. Consider its attributes:

- a circular and upright shape with two carrying handles, non-corrosive material and no moving parts;
- readily available and inexpensive;
- tough, light-weight and watertight.

HERE'S HOW TO USE IT (step by step):

- 1) Leaving 6 to 8 feet of the upper end of the cable out of the can, lay the cable in coils at least a foot in diameter at the bottom of the can and continue coiling until 3 feet of the lower end of the cable are hanging outside the can.
- 2) Properly lubricate the sealing surfaces of the underwater connectors and connect the multiprobe to the cable making certain that the support bail is fastened securely to the cable-ring.
- 3) Leaving the storage cup on the multiprobe, place the multiprobe in the center of the can and let it rest on a circular piece of foam rubber for shock protection; then place the circulator, disconnected from the cable, beside the multiprobe at the bottom of the can.
- 4) Connect the display to the upper end of the cable and place it along with the remainder of the cable in the can. If the battery has been charged, connect it to the display, making sure that it is off, and place it in the can.
- 5) Store the system in this manner until ready for calibration and use.
- 6) Place the can at the calibration station, remove the display, battery and multiprobe and check the battery voltage. Calibrate the system, recharge the battery, if necessary, and replace all compo-

nents in the can along with the white plastic lid for the storage cup.

- 7) Transport the system to the field. At the work station or on board your boat, remove the display and battery and position them for use.
- 8) Remove the storage cup and thread the circulator onto the multiprobe without mating their connectors; replace the multiprobe/circulator assembly in the bottom of the can and collect enough water in the can to cover the sensor chamber. Retain the water in the storage cup until the survey is completed.
- 9) When arriving at the first monitoring station, turn the multiprobe on, connect the circulator connectors and lower the multiprobe into the water a few feet. (Don't forget to hold the transmitter by the bail as you lower it to the water.) When thermal equilibrium is assured, begin profiling by playing out the cable as required.
- 10) When the profile has been completed, retract the cable, hand-over-hand, (grasping the bail as the multiprobe comes out of the water) and stack the cable loosely in the can with no attempt to coil. There will be no net twist in the cable.
- 11) Replace the multiprobe and circulator carefully between the coils until the sensors are underwater in the can, turn the multiprobe off and proceed to your next station, repeating the sequence at each location.
- 12) When your survey is completed, pour the water out of the can, detach the circulator, install the storage cup and place all components in the can for transportation back to the lab.
- 13) At the lab, dry all components, perform any needed maintenance, charge the battery, recoil the cable, if necessary, and store until your next survey.

Alter the sequence to suit your needs, but... remember the 4 DON'TS and *minimize* your "downtime" and "repair-bill"!



Application Note #105:

A Comparison of Three Dissolved Oxygen Measurement Methods

Recessed Cathode, LoFlow™ Membrane, and Standard Membrane

The Problem

For decades, the Clark-type polarographic oxygen detector has been the workhorse of aqueous dissolved oxygen (DO) measurements. Popularized by Yellow Springs Instruments, the Clark sensor with a Standard Membrane (one-mil Teflon™) is small, accurate, inexpensive, and easy to calibrate. However, while excellent for routine spot measurements and short-term monitoring, the Standard has two shortcomings in long-term monitoring situations.

First, the Standard requires circulation of the water being analyzed. If the water is not moving at about one foot per second or more, a stirrer or pump must be used to prevent large measurement errors. Such flow-creating devices are expensive, power-hungry, and, maintenance-wise, not well-suited to long-term monitoring.

Second, the Standard is sensitive to membrane foulants. Active foulants (such as photosynthetic algae) produce and/or consume oxygen and so will bias readings high and/or low. Passive foulants (such as sediments or oil) shield the membrane from DO in the sample and thus bias readings low. Under extreme conditions, foulants can render a Standard useless in just a few hours.

As an alternative to the Standard, one company produces a DO sensor that emits chlorine gas to reduce active fouling, but the sensor is still sensitive to sample flow and passive fouling. Several groups are working on a "pulse" sensor that is not sensitive to sample flow, but is sensitive to active fouling and cannot make continuous measurements. Another firm provides a unique "non-consumptive" sensor that is relatively insensitive to flow and passive fouling, but is affected by active foulants, and, because of its permanently-fixed membrane, cannot be serviced in the event of damage or failure.

So, if you want to make unattended measurements of DO for more than a few hours at a stretch, what do you do? Hydrolab offers two alternative methods, the Recessed Cathode sensor and the LoFlow™ Membrane.

The Recessed-Cathode DO sensor (RC) is similar to the Standard, except that the gold cathode is recessed from the underside of the membrane to reduce the electro-chemical consumption of oxygen. And, the RC employs six small cathodes instead of a single large cathode.

The LoFlow™ Membrane (LoFlow; patent pending) is a proprietary polymer membrane with unique permeability and porosity properties. Unlike the RC, it uses the same basic parts as the Standard. In fact, a Standard can be converted to a LoFlow (and vice versa) simply by changing the membrane on the sensor.

Compared to the Standard, these two sensors offer a substantial reduction in:

- flow sensitivity
- fouling sensitivity

There is, however, no free lunch involved here. The insensitivities to flow and fouling are traded for an increase in:

- calibration time
- response time to temperature change
- oxygen response time
- long-term drift
- sensor wear-out

These seven criteria will be discussed individually. Comparisons will be made between the average output of two each RC, LoFlow, and Standard sensors. All tests except the temperature-response tests were made at 25°C, and all tests except zero response and flow sensitivity were made in a stirred water bath. The standard measurement level for each test is 100% of Full Scale, which represents either the initial equilibrated readings, or the final equilibrated readings. For instance, in the Long-Term Calibration Drift comparison, 100% FS is the initial equilibrated reading for each sensor: the saturation value at 25°C, which is about 8.4 mg/l.

The numbers reported here are not intended to represent maximum, minimum, or even typical results. They cannot be used honestly as product specifications because of variations in field conditions. Instead, they are illustrations of the effects of field-like phenomena that must be considered when employing any DO sensor. If nothing else, the information demonstrates that DO monitoring is by no means an exact, or even well-understood, science. You must consider all the benefits and disadvantages of each method according to the requirements of your particular application.

Flow Sensitivity

Figure 1a shows the result of a test in which readings were made after stirring was stopped (at time zero). The RC exhibited a flow sensitivity of -8%; the LoFlow, -14%; the standard, -45%.

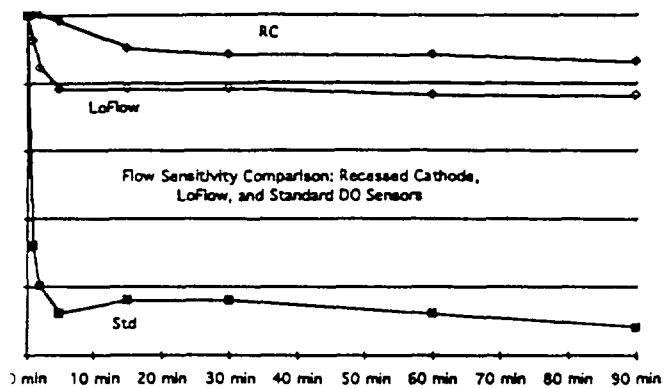


Figure 1a

Note that this is the worst case of zero flow, a situation unlikely in the field and in fact, rather difficult to achieve in the lab. Another test was made comparing the LoFlow and Standard at very low, but non-zero, flows. Figure 1b shows, for the LoFlow, a flow sensitivity of just -6% at the minuscule flow of one mil per second. The Standard, on the other hand, exhibits a -45% error.

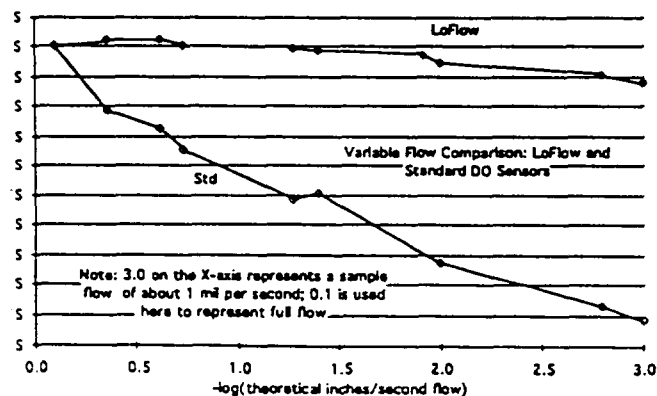


Figure 1b

Because the LoFlow is expected to be used in situations of low sample flow, Hydrolab instruments automatically boost the LoFlow reading by 2.5%. For most field work, this changes the -6% error to approximately a $\pm 3\%$ error, due to flow.

Fouling Sensitivity

Only sensitivity to passive foulants can be measured in a well-controlled situation, and even this test is artificial. Each sensor was equilibrated in stirred water with from zero to four layers of lens-cleaning paper covering the sensor's membrane. A coating of semi-permeable "fouling" is thus simulated (as demonstrated by the immediate drop-off in the readings from the Standard sensor). In the case of four layers (Figure 2), the RC and LoFlow exhibited a fouling sensitivity of about -2%; the same foulant caused the Standard to show an error due to fouling of -18%.

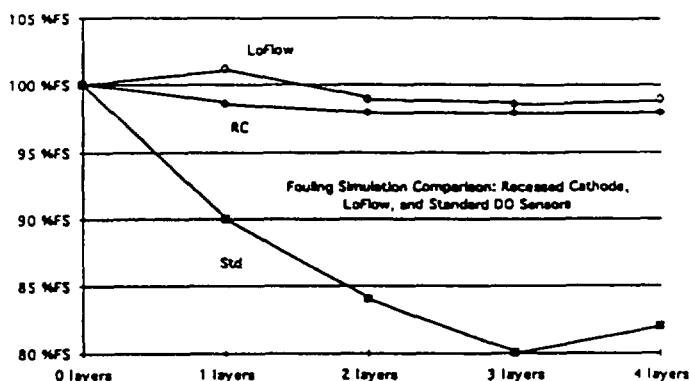


Figure 2

Calibration Time

Figure 3 shows that the RC reached 95% of its equilibrium value in about 145 minutes; the LoFlow in less than 5; the Standard in less than 1.

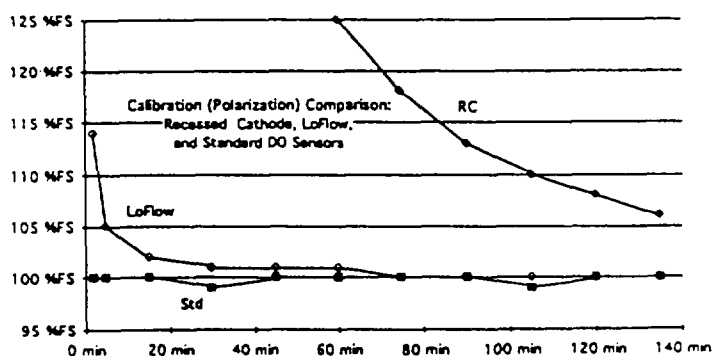


Figure 3

Calibration time was measured as a worst case by replacing each sensor's electrolyte and membrane, and then waiting for equilibration as the sensors repolarize.

In fact, regardless of sensor type, we recommend that you wait until the next day to calibrate if you have changed a membrane. This is especially important for new sensors, since equilibration time seems to decrease with age. While frequency of calibration is best determined by the user, frequent changing of the electrolyte (say, every two weeks) will prolong the life of the RC and the LoFlow. This is because the RC and LoFlow are usually powered continuously so that a long "warmup" is not required when a reading is needed.

Sensitivity to Temperature Change

Temperature shock can be measured by moving sensors equilibrated in one bath to a bath of a different temperature. Figure 4a shows that in changing from 25°C to 40°C, the RC reached 95% of its equilibrium reading in about 115 minutes; the LoFlow in about 7; the Standard in less than 1.

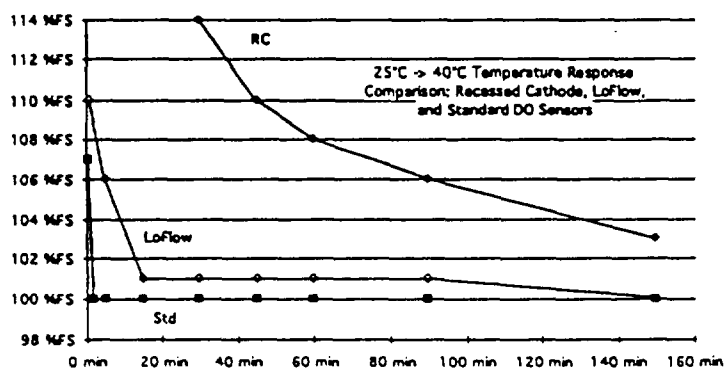


Figure 4a

Figure 4b indicates that in changing from 25°C to 10°C, the RC reached 95% of its equilibrium reading in about 18 minutes; the Standard in about 2. The LoFlow reached the 95% response level immediately.

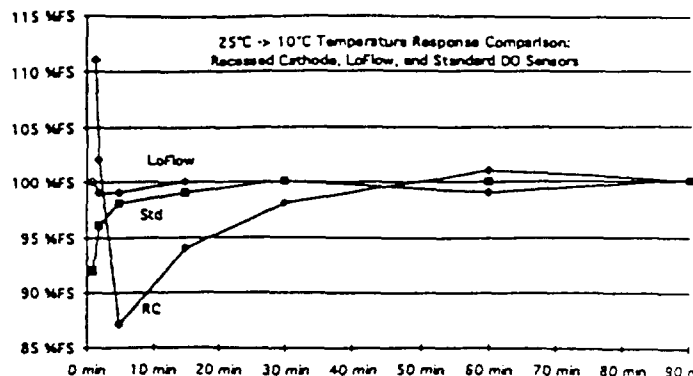


Figure 4b

Oxygen Response Time

Figure 5 shows oxygen response times.

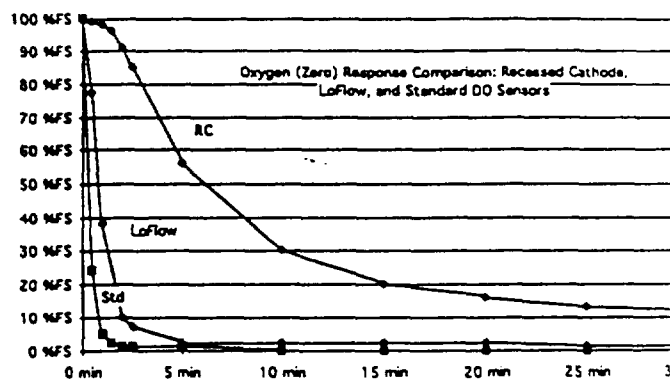


Figure 5

The time required to respond to changes in oxygen level can be estimated by using a worst-case test: moving sensors equilibrated in air to an atmosphere of pure nitrogen gas. Figure 5 shows that the RC reached a 10% of full-scale reading (about 0.8 mg/l) in about 45 minutes (extrapolated); a 5% of full-scale reading was reached by the LoFlow in about 4 minutes; the Standard in less than 1.

Long-Term Calibration Drift

Calibration stability can be illustrated by periodically recording equilibrated sensor readings in stirred water for a number of weeks. Figure 6 shows the behavior of the RC, LoFlow, and Standard over 14 days.

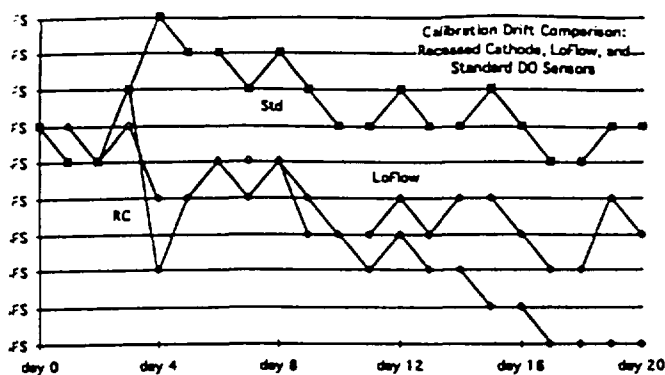


Figure 6

In addition to the passage of time, such operational conditions as temperature shock can also produce calibration shifts. For instance, the large calibration departure on Day 4 was probably caused by drying of the membranes during the nitrogen testing that took place on Day 3.

Sensor Wear-Out

Most polarographic DO sensors, if not continuously powered, can last for years. The RC, because of its relatively long equilibration time, must be continuously powered and so can be used up within a year if conditions are unfavorable. The same applies for a continuously-powered LoFlow. While no hard data exists on longevity under field conditions, sensor life can be extended by frequent changing of the electrolyte (every two weeks, for instance) and by removing the electrolyte completely when the sensor is not going to be used for a week or more.

Summary

In situations where flow is adequate (\geq one foot per second) and fouling is not a problem, the Standard Membrane¹ outperforms the Recessed Cathode² and LoFlow Membrane³ dissolved oxygen measurement methods. An example of such a situation is day-to-day profiling or sampling with a stirring device.

If flow cannot be guaranteed, or sensor fouling is a problem, and an overall measurement tolerance of $\pm 5\%$ of reading is acceptable, the LoFlow Membrane outperforms the Standard Membrane method. Such a situation is unattended monitoring lasting more than a day.

While the Recessed Cathode method performed well in situations requiring reduced sensitivity to flow and fouling, the new LoFlow Membrane method is more effective.

The LoFlow Membrane and Standard Membrane methods use the same sensor; only the easily-exchanged membranes are different.

Long-term calibration stability varies with deployment conditions for any measurement method.

The tests herein are designed for guidance and not definition; the specific requirements and conditions of your field application must be considered in your selection of DO measurement systems.

¹ used on the Surveyor® II System, H2O® and H2O®C Multiprobes, and DataSonde® 3 Multiprobe Logger

² used on the DataSonde® I and DataSonde® II Transmitters

³ used on the H2O® and H2O®C Multiprobes, and DataSonde® 3 Multiprobe Logger

Q: How long will the batteries in my Hydrolab instrument last?

A: It depends on the model (H20, H20G, Reporter, DataSonde 3, Surveyor 3, or Scout 2) and how you are using it (continuous duty, with Stirrer, etc.). The following guidelines are the expected battery life for continuous operation at 25°C⁽²⁾; if your data collection mission is critical, consider shorter deployments and test your assumptions.

H20®, H20®G, and Reporter™ Multiprobes

Battery Life (hours)

The H20, H20G and Reporter are usually powered by the Hydrolab Rechargeable Battery Pack (RBP-6AH)⁽¹⁾.

No Stirrer Attached	90
Stirrer Attached	57

Scout® 2 Display

Battery Life (hours)

The Scout 2 internal battery pack is 10" AA" alkaline batteries that are user-replaceable, but not rechargeable. The Scout 2 external battery pack is the Hydrolab Rechargeable Battery Pack (RBP-6AH)⁽¹⁾.

	Internal Batt	External Batt
No Stirrer Attached	24.5	60
Stirrer Attached	11.5	25

DataSonde® 3 Multiprobe Logger

Battery Life (days)

The DataSonde 3 internal battery pack is 10" AA" alkaline batteries that are user-replaceable, but not rechargeable. The DataSonde 3 external battery pack is the Hydrolab Rechargeable Battery Pack (RBP-6AH)⁽¹⁾. The Submersible Battery Pack (DS3-SBP) contains 12 type "C" alkaline batteries that are user-replaceable, but not rechargeable.

	Interval (min)	Warmup (min)	DS3-IBP internal battery (days)	DS3-SBP submersible battery (days)	RBP-6AH rechargeable battery (days)
No Stirrer Attached	continuous	n/a	0.9	4.2	3.5
	15	2.0	7	31	26
	15	0.5	27	123	102
	30	2.0	14	62	52
	30	0.5	54	242	202
	60	2.0	27	123	102
	60	0.5	104	469	391
	120	2.0	54	242	202
	120	0.5	197	886	738
	continuous	n/a	0.5		2.0
Stirrer Attached	15	2.0	4		15
	15	0.5	16		61
	30	2.0	8		30
	30	0.5	32	N/A	120
	60	2.0	16		61
	60	0.5	63		236
	120	2.0	32		120
	120	0.5	122		456

Surveyor® 3 Display Logger

Battery Life (days)

The Surveyor 3 internal battery pack is a rechargeable Ni-Cad pack. The Surveyor 3 external battery pack is the Hydrolab Rechargeable Battery Pack (RBP-6AH)⁽¹⁾.

	Interval (min)	Warmup (min)	SVR3-IRBP internal battery (days)	RBP-6AH external battery (days)
No Stirrer Attached	continuous	n/a	0.6	1.7
	15	2.0	4	12
	15	0.5	18	50
	30	2.0	9	25
	30	0.5	36	99
	60	2.0	18	50
	60	0.5	71	196
	120	2.0	36	99
	120	0.5	137	380
	continuous	n/a	0.5	1.3
Stirrer Attached	15	2.0	3	9
	15	0.5	14	39
	30	2.0	7	19
	30	0.5	28	78
	60	2.0	14	39
	60	0.5	55	154
	120	2.0	28	78
	120	0.5	109	302

Notes: (1) The Hydrolab Rechargeable Battery Pack (RBP-6AH) is rated at 12 volts DC, 7 amp-hours. Other 12 volt batteries may be used.

(2) RBP-6AH: derate 20% if operating at -5°C;

DS3-IBP and DS3-SBP: derate 25% if operating at 0°C;

SVR3-IRBP: derate 40% if operating at 0°C.



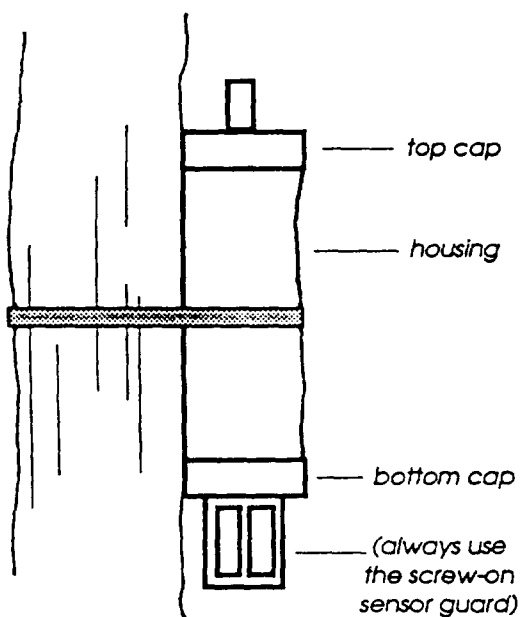
Application Note #107: Securing Multiprobes to a Structure

When strapping a multiprobe to a structure, particular attention should be paid to the placement of the straps on the multiprobe. The straps should be placed so that the pressure is applied to the top and bottom caps. The straps should not be installed so as to squeeze the housing.

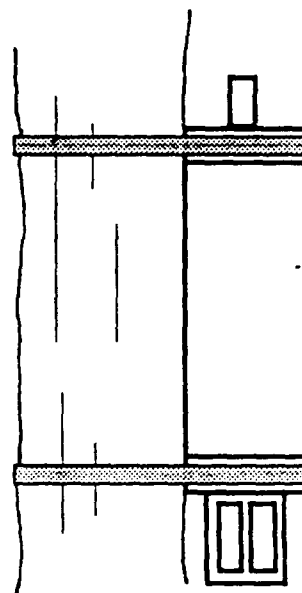
Web belts and bungi cords are recommended. Worm-gear hose clamps should be avoided or their placement

around the housing may collapse the housing and cause leakage.

When deploying a multiprobe for an extended period, it is recommended that duct tape or electrical tape be used to cover the joints between the housing and the top and bottom caps. This prevents sediment and grit from collecting at the o-rings.



wrong way



right way



Application Note #108

Troubleshooting Dissolved Oxygen

When troubleshooting DO (dissolved oxygen), there are many variables which should be considered. The following is a checklist to ensure that your setup is correct, and that the DO sensor is properly serviced. Please refer to section 3.7 of the operating manual, and verify the following:

- 1) Has the correct membrane (Standard or Lo-Flow™) been selected through the Variables Menu, (V), and installed properly (no wrinkles or bubbles)?
- 2) If the LoFlow™ membrane is used, are the DO warm-up batteries in good condition and installed properly? They should be installed unless the instrument is on continuously.
- 3) Is the DO sensor completely filled (no bubbles) with correct electrolyte, either the DO electrolyte supplied with the maintenance kit or 2 molar potassium chloride?
- 4) Is the calibration setup (air cal) correct, and have the DO readings stabilized?
- 5) Is the correct barometric pressure being used to calibrate?

If the answer to all these questions is yes and the instrument will not calibrate, remove the membrane and electrolyte, rinse the DO sensor with deionized water, and then rinse with DO electrolyte (3 times). Refill the DO sensor with DO electrolyte, install the correct membrane, allow 30 minutes for stabilization, and then attempt calibration.

If the instrument still won't calibrate, make the checks listed below:

- 1) If the anode (small, silver, triangular shape inside DO sensor) is dark gray or black, the DO sensor may have been consumed, and may need replacing if cleaning does not restore anode to light gray or white appearance.
- 2) Remove the membrane and electrolyte, rinse with deionized water, and thoroughly dry the DO sensor cavity. Connect the instrument to a display or a computer, enter Variables Menu (V), select DO (O), select LoFlow™ (L), and select uncompensated (U). The DO mg/l reading should be less than 0.02. If not, and a Fluke or other ohm meter is available, remove the two Allen screws securing the sensor assembly to main body, pull out the sensor assembly and disconnect the gray rectangular 10 pin connector (J3) which connects the sensors to the circuit board. Set the ohm meter to the highest scale and check the resistance between the anode and cathode (gold ring) of the DO sensor. Alternatively, you may check the resistance between J3 pin 8 (anode - gray wire) and J3 pin 10 (cathode - yellow wire). There should be no reading (open circuit). There should be continuity (0 ohms) between the cathode and J3 pin 10 and between the anode and J3 pin 8.

If there is not an open circuit between the anode and cathode, or no continuity between J3 pin 10 and the cathode, or J3 pin 8 and the anode, the DO sensor may need to be replaced.
- 3) If the above checks are O.K., polish the gold cathode ring with a lint-free cloth, or if necessary, a soapy SOS steel wool pad. Then clean the anode by filling the cavity with a 5-10% ammonium hydroxide (NH₄OH) solution or regular household ammonia and allow to soak for thirty minutes. Afterwards, thoroughly rinse with deionized water, and rinse 3 times with DO electrolyte. Caution: Use a syringe or other device to ensure that the solution does not come in contact with the gold cathode ring. If this does happen, rinse immediately and polish cathode again if needed. Replace the electrolyte and DO membrane. Enter Variables Menu (V), select DO (O), then select correct membrane and compensation.
- 4) If the instrument still cannot be calibrated after waiting for stabilization, and another instrument is avail-

able, switch the entire sensor assembly to determine whether the problem is in the sensor or the associated electronics.

If the instrument will calibrate but there is reason to believe that it is not accurate, then consider the following:

- 1) Is there adequate flow? With the Standard Membrane you must have a flow rate of at least 1 ft/sec of water past the membrane, or you must have a stirrer and have it enabled.
- 2) Is the warm up time sufficient? When using the LoFlow™ Membrane, warm-up batteries should be used or ensure that enough time is allowed to reach the equilibrium value. Response is 95% in five minutes with LoFlow™ or one minute with a standard membrane, depending on temperature and DO.
- 3) Has the membrane fouled? Fouling is a site-specific problem and largely a function of the physical, chemical, and biological characteristics of the deployment environment. Deployment durations must be determined by the user.
- 4) If you are comparing DO readings with those of another instrument, is the DO standard that you are comparing against temperature and/or salinity compensated? Hydrolab DO readings are always temperature compensated, and salinity compensated if enabled to do so via the Variables Menu (V).
- 5) If you are comparing a Hydrolab reading with a Winkler titration, be certain that the Hydrolab is set for salinity compensation.
- 6) Remember that the errors between two systems are cumulative, i.e. if your Winkler is plus or minus 0.2 mg/l and Hydrolab is plus or minus 0.2mg/l then, acceptable error is plus or minus 0.4 mg/l.

Also, when using the instrument for profiling, it is best to use the Standard Membrane and a Stirrer, as this gives the quickest response. A stirrer may not be necessary if the flow is adequate, that is, more than one ft/sec. If doing unattended logging, it is best to use the LoFlow™ Membrane with warm-up batteries, as this will use less power (no Stirrer) and will not be affected by fouling as quickly.

The above guide is only a summary of things to check. For more information, refer to the operating manual and review the following sections:

- *Data Displays & Menus, Section 2.5.4*
- *Maintenance & Calibration, Section 3.7*
- *Technical Notes, Sections 5.1-5.3*
- *Appendix 1:*
 - *Performance Manual for Field Water Quality Instrumentation (part 6)*
 - *Dissolved Oxygen Sensor Life (Application Note #101)*
 - *A Comparison of Three Dissolved Oxygen-Measurement Methods (Application Note #105)*



Application Note #109

Parameter Specifications for Hydrolab Multiprobes

PARAMETER	RANGE	ACCURACY	SENSOR	COMPENSATIONS	RESOLUTION	CALIBRATION	RESPONSE TIME ¹⁰	STABILITY ¹¹	OUTPUT OPTIONS
TEMPERATURE	-5 to 50°C	±0.15°C ³	thermistor	none req'd	0.01°C	none req'd	< 1 minute	three years	output in deg F
SPECIFIC CONDUCTANCE	0 to 100 mS/cm ¹	± 1% of range ¹	6-electrode cell	automatic for temp (25°C) ⁶	4 digits ⁸	KCl or seawater standards	< 1 minute	six months	output in salinity, conductivity, TDS, or resistivity; output in µS/cm
pH	0 to 14 units ²	±0.2 units ⁴	glass pH; rebuildable or low ionic strength reference electrode ⁴	automatic for temperature	0.01 unit	pH 7 buffer, plus one slope buffer	< 1 minute	one month	none
DISSOLVED OXYGEN	0 to 20 mg/L	±0.2 mg/L ⁵	rebuildable polarographic; 1 mil Teflon™ or LoFlow™	automatic for temp & salinity ⁷	0.01 mg/L	saturated air, Winkler, or saturated water	< 1 minute ⁵	one month	w/o salinity correction, % Saturation
REDOX	-999 to 999 mV	±20 mV ¹³	Pt electrode	none req'd	1 mV	quinhydrone, or transfers ¹⁷	varies ⁹	one month	none
DEPTH	0 to 100 m	±0.45 m ¹⁴	strain-gauge transducer	automatic for sp. conductance ¹⁶	0.1 m	set zero in air	< 1 minute	one month	output in feet
LEVEL	0 to 10 m	±0.09 m ¹⁵	strain-gauge transducer	automatic for sp. conductance ¹⁶	0.01 m	set zero in air	< 1 minute	one month	output in feet
SALINITY	0 to 70 ppt ¹²	±0.2 ppt ¹²	calculated from specific conductance	none req'd	0.1 ppt	uses calibration from specific conductance	< 1 minute	one month	none
TURBIDITY	0 to 100 NTU; and 100 to 1000 NTU	±5% of range ¹⁸	ISO 7027 nephelometric with 880nm infrared and transmissive correction	Additional transmissive correction improves linearity and compensates for drift due to fouling	0.1 on 100 NTU range; and 1 on 1000 NTU range	dilutions of Formazin or AEPA-1 polymer beads	< 1 minute	180	transmissive correction can be disabled to provide nephelometric-only readings

For an explanation of postscripted values, see reverse.

* Remember, not all sensors are available on all multiprobes. Consult the multiprobe product flyer or Hydrolab Ordering Guide for sensor availability.

Qualifications for Hydrolab Multiprobe Specifications

(1) The Freshwater cell block provides three Specific Conductance ranges: 0 to 0.15, 0.15 to 1.5, and 1.5 to 10 mS/cm. The Saltwater cell block provides ranges of 0 to 1.5, 1.5 to 15, and 15 to 100 mS/cm. The three ranges for either of the two cell blocks are changed automatically (autoranged) to provide the most digits available. The cell blocks themselves can be changed manually in a few seconds. The multiprobe must be notified, via the keyboard, of the change in cell blocks, and recalibration is required.

Although the multiprobe will measure the full 0 to 14 unit pH range, it is not recommended that the sensors be exposed to pH extremes outside the 2 to 12 unit range.

Hydrolab's standard thermistor provides $\pm 0.20^\circ\text{C}$ accuracy worst case and $\pm 0.13^\circ\text{C}$ using the 95% Certainty (most-probable-error) method for calculating accuracies. This means that more than 95 out of 100 multiprobes will meet the $\pm 0.15^\circ\text{C}$ specification.

The pH accuracy is valid for waters of Specific Conductance greater than 0.2 mS/cm, when using Hydrolab's standard, rebuildable reference electrode. This accuracy can be met in very fresh waters (Specific Conductance less than 0.2 mS/cm) if you use Hydrolab's optional LISRE reference electrode and follow very particular maintenance and calibration procedures. The LISRE reference electrode, employed in the H20-LPH pH system, is not refillable, but may last 3 years or more.

The DO specifications listed are for the Standard Membrane (1-mil Teflon™). If natural flow is inadequate (i.e., less than 25 cm per second) and a Stirrer or Flow Cell cannot be used, the multiprobe can also accommodate the Hydrolab LoFlow™ Membrane. This method changes the accuracy specification to the greater of ± 0.5 mg/l or $\pm 2.5\%$ of reading, or flows ≥ 1 cm/minute. Also, the response time is lengthened. Please ask for the Hydrolab publication explaining the benefits of the LoFlow™ Membrane.

The Temperature compensation for Specific Conductance can be disabled easily if "raw" Conductivity readings are needed. The compensation is based on 0.01N KCl for the freshwater cell block, and standard seawater for the Saltwater cell block.

(7) The Salinity compensation for DO can be disabled easily if raw DO readings are needed. The compensation is based on the effects of concentrated and diluted seawater.

(8) The 4-digit resolution for Specific Conductance depends on which of the 3 automatically-selected ranges is in use. For instance, for Specific Conductance measurements made with a Freshwater cell block, a conductivity of 0.130 mS/cm would be read as .1300; resolution would be to ten-thousandths of mS/cm. A Specific Conductance of 10.167 mS/cm would be read as 10.16 mS/cm; resolution would be to hundredths of mS/cm. If the optional display, $\mu\text{S}/\text{cm}$, is chosen, the resolution for Specific Conductances over 9999 $\mu\text{S}/\text{cm}$ will be five digits. However, to prevent "noisy" readings, the last digit will be a zero.

(9) The time required for a Redox sensor to respond to a step-change in Redox is highly variable. It depends a lot on the condition of the surface of the platinum electrode, and even more on the direction of the step-change. Because response time is little affected by non-Redox sensor items, such as electronic design or the effects of other sensors, the response time of Hydrolab's Redox sensor is virtually the same as that of other Redox-measurement instruments.

(10) Response time is the time required for a measurement to accomplish 95% of a step-change in only that measurement. For instance, if Temperature changed suddenly from 25°C to 35°C , Temperature's time response would be the time required for the reading to change to 95% $(35 - 25) + 25 = 34.5^\circ\text{C}$.

(11) Stability is a sensor's ability to read within its accuracy specifications in the same standard that was used for calibration. Certain situations can adversely affect repeatability. For example, a reference electrode soaked one month in very-low Specific Conductance water cannot ordinarily be expected to produce accurate pH (or Redox) readings. Similarly, a DO probe covered with blooming algae is not going to give accurate DO readings. The stability specifications are based on an analysis of the sensor electronics and not on direct testing, because of the difficulty in defining such a test.

(12) Even though the multiprobe will report salinities in the 0 to 70 ppt range, the term "Salinity" is not well-defined outside the 30- to 40-ppt range. The Salinity accuracy is valid in the

30- to 40-ppt range when the system is calibrated with a seawater standard at near 36 ppt.

(13) The Redox accuracy refers to true electrode voltage. Actual readings are subject to slow electrode equilibration times and uncertainty in measurement theory and calibration. A typical as-measured accuracy might be $\pm 50\text{mV}$. Accuracy is aided in very fresh waters (Specific Conductance less than 0.2 mS/cm) by Hydrolab's optional LISRE reference electrode (see (4)).

(14) The Depth accuracy is the 95% Certainty (most-probable-error) accuracy, based statistically on the worst-case errors such as drift, temperature compensation, tilt error, etc. The Depth transducer is sealed and so does not use atmospheric venting; barometric pressure changes will produce a small additional error.

(15) The Level accuracy is the 95% Certainty (most-probable-error) accuracy, based statistically on the worst-case errors such as drift, temperature compensation, tilt error, etc. This accuracy requires that the user employ atmospheric venting if changes in barometric pressure are to be considered. The accuracy may be improved in situations where temperature changes are small and changes in Level, rather than the exact Level, are of primary interest.

(16) The Depth and Level readings are compensated for Salinity (that is, water density) so that readings are accurate whether made in fresh or salt waters.

(17) A transfer standard is a calibration solution or standard graded by another measurement method, such as a chemical titration (e.g., a Winkler). In the case of Redox, a transfer standard might be a solution measured by a trusted laboratory pH-mV meter. For many purposes, it is not necessary to calibrate Redox at all.

	% range on cal range	% range on non-cal range *
at cal temp	± 5	± 10
not at cal temp	± 10	± 15

* For nephelometric only, 100 NTU cal range is only valid to 500 NTU on 1000 NTU range

note: These specifications apply over the operating temperature range of -5 to 50°C , and over the operating voltage range of 9.6 to 16VDC, for well-maintained sensors in clean, unchanging waters. There are many situations, such as biofouling, that will negate extrapolation of these specifications to field conditions.

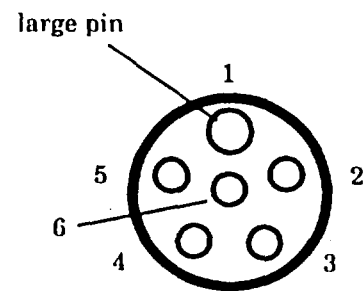
APPENDIX 4

Technical Data

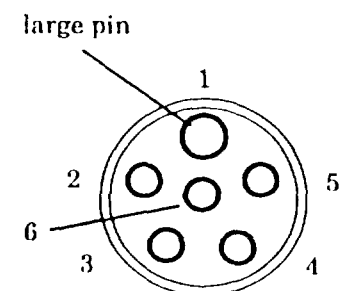
DataSonde 3 to RS-232 (with 9D) Pinout

	DS3	Hydrolab Underwater Cable			HYD-IC9			
Function	6PM bulkhead conn**	6PF marine conn to DS3	2PF marine conn to Stirrer*	6PM metal shell conn	6PF charger conn	9PD female conn (to PC)	4P charger conn (to batt)	RBP-6AH battery
+12	1	1	—	A	A	—	A	A "+"
GND	2	2	2	B	B	5	C	C "-"
TXD (to DS3)	3	3	—	C	C	3	—	—
RXD (from DS3)	4	4	—	D	D	2	—	—
SDI Data	5	5	—	E	E	—	—	—
Stirrer	6	6	1	—	—	—	—	—

- * Only if HYD-SC option ordered
- ** Some bulkhead connectors arriving from the manufacturer are misnumbered or not numbered. Use this pictorial to orient numbering system.



6 pin male bulkhead connector **



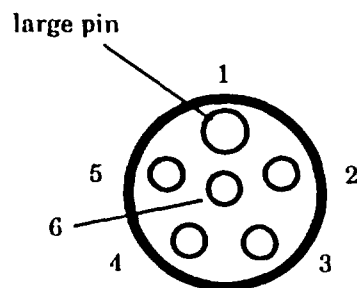
6 pin female marine connector

DataSonde 3 to RS-232 (with 25D) Pinout

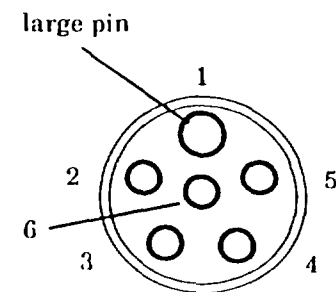
	DS3	Hydrolab Underwater Cable			HYD-IC25			
Function	6PM bulkhead conn**	6PF marine conn to DS3	2PF marine conn to Stirrer*	6PM metal shell conn	6PF charger conn	25PD female conn (to PC)	4P charger conn (to batt)	RBP-6AH battery
+12	1	1	—	A	A	9	A	A "+"
GND	2	2	2	B	B	7	C	C "-"
TXD (to DS3)	3	3	—	C	C	2	—	—
RXD (from DS3)	4	4	—	D	D	3	—	—
SDI Data	5	5	—	E	E	—	—	—
Stirrer	6	6	1	—	—	—	—	—

* Only if HYD-SC option ordered

** Some bulkhead connectors arriving from the manufacturer are misnumbered or not numbered. Use this pictorial to orient numbering system.



6 pin male bulkhead connector **



6 pin female marine connector

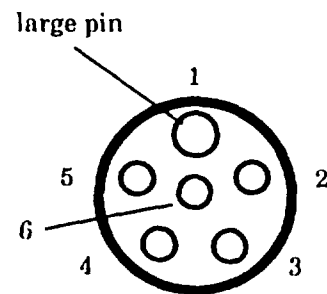
DataSonde 3 to SDI Pinout

*Hydrolab
supplied*
←

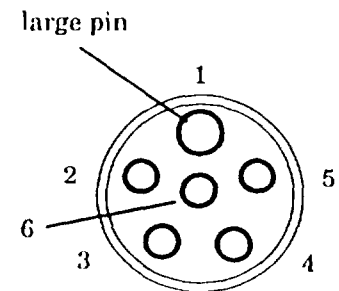
	DS3	Hydrolab Underwater Cable			HYD-SDIC			
Function	6PM bulkhead conn**	6PF marine conn to DS3	2PF marine conn to Stirrer*	6PM metal shell conn	6PF charger conn	wire color	External SDI batt	Campbell BDR SDI-12 conn
+12	1	1	—	A	A	brn	"+"	B
GND	2	2	2	B	B	red	"-"	C
TXD (to DS3)	3	3	—	C	—	—	—	—
RXD (from DS3)	4	4	—	D	—	—	—	—
SDI Data	5	5	—	E	E	orn	—	A
Stirrer	6	6	1	—	—	—	—	—

* Only if HYD-8C option ordered

** Some bulkhead connectors arriving from the manufacturer are misnumbered or not numbered. Use this pictorial to orient numbering system.



6 pin male bulkhead connector **



6 pin female marine connector

DataSonde 3 Connectors

# of pins	Bendix Part No.	Bendix Part No.
4	HYD-IC POWER (metal shell) PT01A-8-4-SW(SR)(005)	<--- mates to ---> PT06A-8-4-PW(SR)(005)
6	Hydrolab Underwater Cable (metal shell) PT06A-10-6-PW(SR)(005)	<--- mates to ---> PT07A-10-6-SW(005)

DataSonde 3 Currents

(@ 12VDC input)

DataSonde 3 Supply Current	
Standby/Sleep	35–50 μ A
RS-232 mode (without Stirrer)	75–85 mA
RS-232 mode (with Stirrer)	115–105 mA
SDI mode "command" response	40–50 mA
SDI mode "measure" (without Stirrer)	75–85 mA
SDI mode "measure" (with Stirrer)	115–205 mA

APPENDIX 5

Using the DataSonde 3 SDI-12 Interface

Appendix 5

Using the DataSonde 3/SDI-12 Interface

A5.1 Introduction

SDI-12 is an industry-originated, serial digital interface bus designed to allow an operator to connect a wide variety of transducers (meteorological, hydrological, water quality, etc.) to a single data recorder (SDI-12 Controller) with a single cable bus. This means that you could, for instance, connect both your Hydrolab DataSonde 3 Multiprobe Logger and a Paroscientific pressure transducer to a Campbell CR-10 data recorder and not have to worry about combinations of RS-232, parallel analog, BCD, serial analog, RS-422, etc., types of sensor output.

This appendix assumes that the reader is familiar with the operation of both the DS3 (also called the "multiprobe") and the SDI-12 Controller (called the "Controller", i.e., data recorder or BDR) to be employed with the multiprobe.

A5.2 A Brief Theory of Operation

When the Controller sends a "break signal", your DS3 awakens and captures the Controller command following the break signal. If the command is valid, your DS3 reads its address setting to see whether or not its address (i.e., its name) is in fact being called, or if the address of some other device (at another location) is being sought. If the Controller is looking for a different address, your DS3 will go back to sleep until another break signal is received.

If the address being sent belongs to your DS3, your DS3 will scan the instructions coming from the Controller to see what action is required. The two most important commands at this time are:

Measure: If your DS3 receives the Measure command, it will report back to the Controller the number of parameters enabled for measurement, and the number of seconds that must pass before the readings can be sent (the delay default is 30 seconds for the multiprobe; this can be changed in the RS-232 mode using the Variables menu: see Section 2.6 in the Operating Manual). The DS3 then applies power to the multiprobe's sensor-measuring circuits, waits for the delay period to pass, and captures all the parameter readings. The DS3 then turns those circuits off and sends a message to the Controller that the readings are now available for transmission.

**ADDITIONAL
INFORMATION**

HYDROLAB[®]

Multiparameter Water Quality Monitoring Instruments

– Operating Manual –



SCOUT[®] 2

Display Unit

Operating Manual ***January 1994***



HYDROLAB CORPORATION

P.O. Box 50116 • Austin, TX 78763

800-949-3766 or 512-255-8841

This operating manual contains trade secrets and confidential information which are proprietary to Hydrolab Corporation. Its use or disclosure in whole or part without the express written permission of Hydrolab Corporation is prohibited.

This operating manual is also an unpublished work protected under the copyright laws of the United States of America. If this work becomes published, the following notice shall apply:

Copyright © 1993 Hydrolab® Corporation
All Rights Reserved

HL#003057, REVISION D

Scout 2 Display Manual
ADDENDUM
December 1994

(upgrades Scout 2 Display Operating Manual to Revision D)

This addendum updates the Scout 2 manual for Software Version 2.20

1. Data Display

A. Data Identification Screen

The left arrow key produces a Data Identification Screen for the currently selected data screen. The Data Identification Screen for the Main Data Screen is:

Imp, °C	DOmg/L	Dpth, M
Cnd, mS	pH	Rdx, mV

The Data Identification Screen for the Alternate Data Screen is:

Salin	Turb-r	Batt, V
DO%sat		HHMMSS

The Data Identification Screens indicate the parameter units where appropriate and alternate parameters such as TDSg/L and Res,K Ω are also indicated if selected.

The Data Identification Screen is also momentarily displayed when entering the data display mode from any Scout 2 menu operation.

B. Time

A "seconds" readout has been added to the time parameter. The time will not indicate a steady, one second update due to the data transmission delay from the multiprobe to the Scout 2 Display.

2. System Menu

A. Parameter Swapping

Some parameters can be moved between the Main and Alternate Data Screens. Select S from the System Menu to begin:

Cond <-> Salin
YN: No

DO% <-> DOmg/L
Y/N: No

Redox <-> Batt
Y/N: No

Select Y to swap the display locations of the indicated parameters. The new locations will remain in effect until changed by a subsequent swap operation. The Data Identification Screen indicates the new parameter locations.

B. Parameters

The % and A entries have been added to the Parameter Menu. Select P from the System Menu:

Parameters
pCS%OYRDA: pH

Use the A option to enable or disable All parameters (except time, temperature and battery). Not all parameters will be available depending on the capabilities of the attached multiprobe. For example, turbidity (Y) cannot be enabled for a Reporter Multiprobe.

A disabled parameter will be blanked in the corresponding location in the data display screen. If a parameter is enabled that is not available in the multiprobe (N/A), then "....." will show in the corresponding location.

3. Calibration Menu

The E and V entries have been added to the Calibration Menu to enable calibration of resistivity and TDS respectively:

Calibrate
pCESV%OYDRTA: pH

If resistivity is currently displayed instead of conductivity, then E must be selected to calibrate resistivity (not C as in previous versions). If TDS is displayed instead of salinity, then V must be selected to calibrate TDS. If calibration of a parameter that is not available on the Data Display is attempted, then a "Param not available" message will appear.

4. Oxygen Variables Menu

The %/O menu in the Oxygen Variables Menu will only be shown if an H2O V2.00 through V2.09 or a DataSonde 3 V1.40 through 1.49 is connected to the Scout 2.

5. Data Logging

Scout 2 Displays (version 2.11 software or higher) now support manual logging when connected to DataSonde 3 or Recorder Multiprobe. The Scout 2 uses the Store function available on the DataSonde 3 and Recorder to store a complete set of readings to the multiprobe's Manual Log File. In addition, the Scout 2 will allow the multiprobe's Manual Log File to be annotated with an up to 20 character message. The DataSonde 3 or Recorder must be connected to a PC for subsequent data downloading or review. The Scout 2 does not support the setup of the unattended logging features of the DataSonde 3 and Recorder.

A. Store

To access the Scout 2 Data Logging Menu, press the Enter key:

Data Logging
SA: Store

To store the current readings, press the Enter key again and the following message will briefly appear before the data display is resumed:

Data Stored!

To cancel the Data Logging Menu, press the Escape key to resume the data display.

B. Annotate

From the Data Logging Menu, press the Left or Right arrow key to move to the Annotate function:

Data Logging
SA: Annotate

Press the Enter key to annotate the logging file:

Annotate
SCOUT 2

Use the Left and Right arrow keys to select one of the 20 positions to modify, and the Up and Down arrow keys to select a new character for that position. When the message is complete, use the Enter key to send the message to the Manual Log file in the multiprobe or the Escape key to cancel the message and resume the data display.

6. Miscellaneous

A. Power Source Error

In Version 2.11 software, the wrong power source would be indicated when the Scout 2 was turned on without a connected multiprobe. This has been corrected.

B. Additional DataSonde 3 and Recorder Support

The Scout 2 now supports 200 meter depth capability for the DataSonde 3 and Recorder Multiprobes.

Scout 2 Display Manual
ADDENDUM
December 1993

(upgrades Scout 2 Display Operating Manual to Revision C)

This addendum updates the Scout 2 manual for the addition of turbidity. It assumes knowledge of the Scout 2 manual. The section numbers reference the pertinent section of the manual which is modified or updated.

PART ONE: INTRODUCTION

New Firmware

All Scout 2 Displays shipped after December 15, 1993 will contain firmware revision 2.10 or higher. The firmware revision number is shown on the start-up screen:

Scout 2, Ver 2.10
(C)1991, Hydrolab

The new firmware provides compatibility with Hydrolab's DataSonde 3 Multiprobe Logger with firmware revisions 1.40 and higher, H20 Multiprobes with firmware revisions 2.00 and higher, and Reporter Multiprobes with firmware revisions 1.04 and higher. Older H20s and DataSonde 3 multiprobes will remain compatible as well.

Generally, the Scout 2 firmware has been modified to support the addition of the turbidity sensor to the DataSonde 3 and the H20 Multiprobes.

PART TWO: DATA DISPLAY & MENUS

When the Scout 2 is attached to a multiprobe capable of operating a turbidity sensor, the turbidity reading will appear on the Alternate Data Screen in the lower left corner. The reading will be suffixed with an "ntu" unit code and replaces the dissolved oxygen (% saturation) reading.

The dissolved oxygen (mg/l) position on the Main Data Screen will now be either the mg/l reading (no unit code suffix) or the percent saturation ("% " unit code suffix) reading depending on the multiprobe setup options.

The Data Status Screen has been modified to show the alphanumeric flags provided by the multiprobe in the screen positions occupied by the readings. For example, if your pH reading is uncalibrated, then pressing the down-arrow key will show an asterisk (*) in the pH location on the screen. The alphanumeric flags for the six parameters on the Main Data Screen will also appear in the appropriate locations. To view the flags for the parameters on the Alternate Data Screen, just press Screen/Escape key.

Press the down-arrow key again to return to the normal data display or the normal data display will return automatically after a few seconds.

The new alphanumeric flags are interpreted as follows:

- ok Data is ok (nothing to report)
- N/A The appropriate sensor has not been installed or has been disabled
- ? Turbidity sensor error (Refer to the multiprobe Operating Manual)
- ! Warm-up batteries are enabled
- \$ Stirrer has been disabled (DataSonde 3 only)
- @ Parameter not compensated, turbidity neph only

Calibrate Menu

Turbidity (Y) has been added to the Calibrate menu:

pCS%OYRTA: Turb

If you have an older multiprobe that does not support turbidity, then you will see the following message if you try to calibrate turbidity:

Menu not available

Variables Menu

1. Turbidity

Turbidity (Y) has been added to the Variable menu:

TCODSY: Turbidity

This menu allows you to modify the turbidity operating mode as outlined in your multiprobe Operating Manual. If your multiprobe does not support turbidity, you will get the "Menu not available" message.

2. Dissolved Oxygen

The dissolved oxygen Variable menu has been modified to allow you to select the type of dissolved oxygen reading to display on the Main Data Screen, since the turbidity reading replaces the dissolved oxygen percent saturation reading on the Alternate Data Screen. You will not see this menu if your multiprobe does not support turbidity since both dissolved oxygen readings are available simultaneously.

System Menu

1. Display Contrast

Hydrolab now uses high contrast "super-twist" display modules that no longer require a contrast adjustment therefore, the display contrast adjustment has been removed from the System Menu.

2. Warm-Up Batteries

You can enable or disable the warm-up batteries in H20 Multiprobes with firmware revisions 2.00 and higher by selecting the B menu option. Refer to the H20 Multiprobe's Operating Manual for further details concerning warm-up batteries.

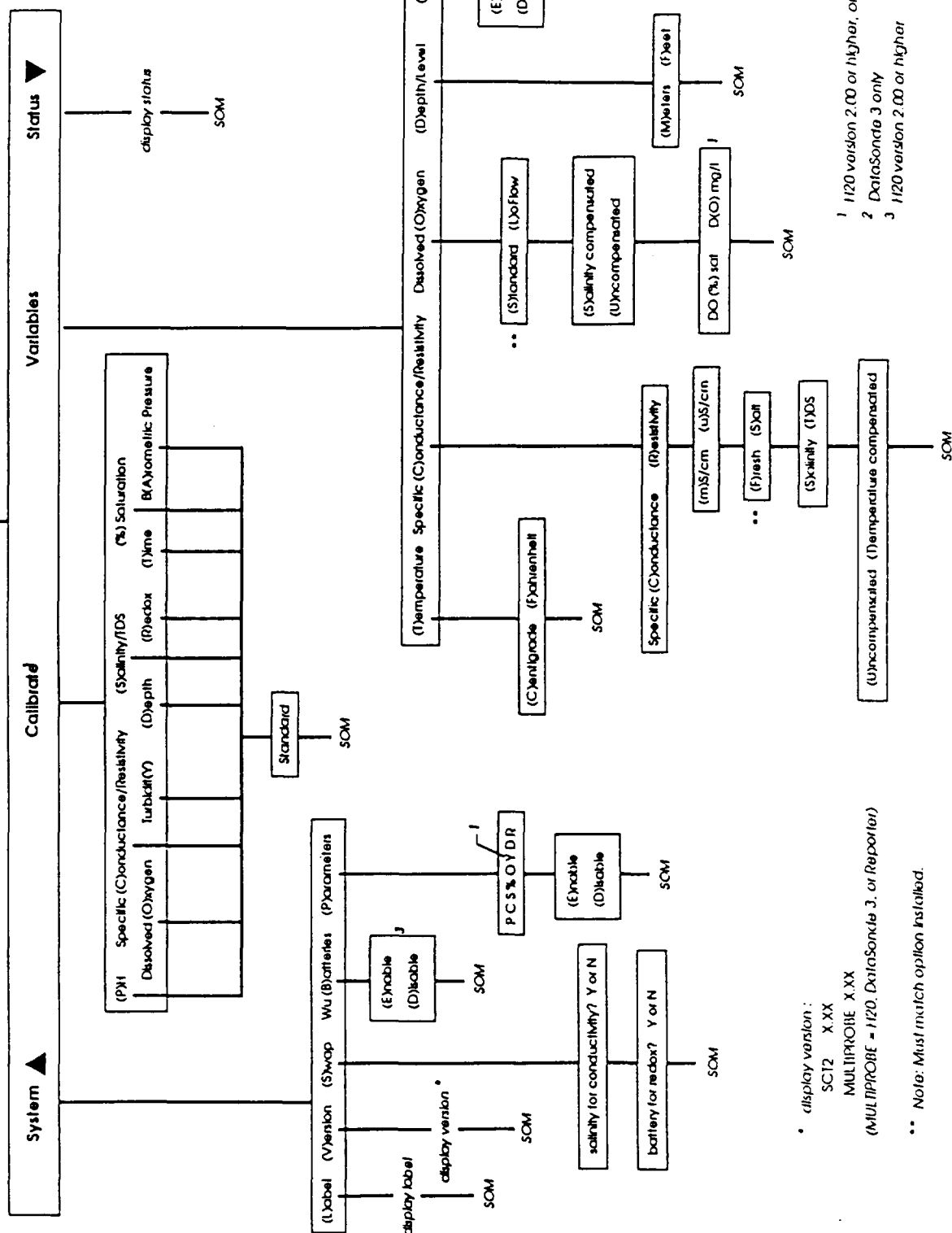
3. Parameters

Turbidity has been added to the Parameters menu.

Figure 2.1 Scout 2 Menu Tree

Version 2.10
12/93

Standard Operating Mode (SOM)
Main or Alternate Data Screen



* display version :
SC12 X.XX
MULTIPROBE X.XX

(MULTIPROBE = 1/20, DataSonde 3, or Reporter)

** Note: Must match option installed.

Scout® 2 Data System Operating Manual
ADDENDUM
October 1991

(upgrades Scout 2 Display Unit Operating Manual to Revision B)

PART ONE: Introduction

All Scout 2 Display Units shipped after October 1, 1991 contain software version 2.00 or higher. The new software requires the new Revision A printed circuit board. The software version number is shown in the start-up screen:

Scout 2, Ver 2.00
(C)1991, Hydrolab

The new software version provides:

1. Compatibility with Hydrolab's DataSonde® 3 Water Quality Multiprobe Logger
2. Audio feedback for the keyboard
3. Stirrer control
4. Parameter display control

PART TWO: DataSonde 3 Multiprobe Compatibility

With version 2.00 (or higher), the Scout 2 Display Unit connects directly to any DataSonde 3 Multiprobe Logger with software version 1.22 or higher. The Scout 2 Display Unit will display all of the DataSonde 3 readings, however, all logging-related functions must be carried out using a terminal or computer (PC). All Calibration and Variable menus are as described for the H20® Multiprobe except the Stirrer control.

The Data Status Screen now indicates the type of instrument that you have connected. The instrument software revision number is shown in the "Version" function of the System menu.

PART THREE: Keyboard Audio Feedback

The Scout 2 Display Unit now has additional hardware that gives you an audio "beep" each time a key is pressed. The audio beep cannot be disabled.

PART FOUR: Stirrer Control

When using the Scout 2 with a DataSonde 3 and a Stirrer, you can conserve battery life by turning the Stirrer off when it is not needed. Remember that the Stirrer may still operate if a programmed logging event in the DataSonde 3 has the Stirrer enabled. Access the Stirrer control in the Variables menu:

Variables
TCODS: Stirrer

Press the Enter key to select the Stirrer Variable menu:

Stirrer On
YN: No

This menu indicates the current status of the Stirrer. If the Stirrer is enabled, the cursor will be flashing on the Y (yes). If the Stirrer is disabled, the cursor will be flashing on the N (no). Use the Right or Left arrow key to position the cursor to the desired menu option, and press the Enter key.

The Stirrer cannot be controlled from the Scout 2 if you are using an H2O. The Stirrer must be physically disconnected from the cable to turn it off. If you attempt to turn the Stirrer on or off using the Scout 2 (and you are using an H2O), then you will get the following momentary error message:

No H2O Stir Control

PART FIVE: Multiprobe Parameter Control

This new System menu feature allows you to further customize your Scout 2 by removing any undesired water quality parameters that may clutter the data display. The Scout 2 no longer automatically enables all of the water quality parameters.

The pH, specific conductance/resistivity, salinity/TDS, dissolved oxygen (both % saturation and mg/L), redox, and depth readings can be removed (disabled) or placed (enabled) on the Scout 2 screen. To enable or disable a parameter, access the Scout 2 menu by pressing the Up arrow key:

System Menu
LVSCP: Label

Move the flashing cursor to the letter P in the menu using the Right or Left arrow key:

System Menu
LVSCP: Parameters

Press the Enter key to select the Parameters menu option:

Parameters
pCS%ODR: pH

Move the flashing cursor to the desired parameter using the Left or Right arrow key and then press the Enter key to get:

pH
ED: Enable

In this example, the desired parameter was pH as displayed on the top line. To display the pH parameter, just press the Enter key (since Enable was already selected). If you wish to disable the pH parameter, then use the Right or Left arrow key to select the Disable option and then press the Enter key. The start-up screen will be displayed for a few seconds while the parameter change is being executed.

Note that any parameters that are disabled will not appear on the Scout 2 data display and will be replaced by a string of five dots (.....). If you try to enable an H2O parameter that does not have a corresponding probe installed then the string of dots will still be shown in the Scout 2. If you try to do this on a DataSonde 3 then the parameter will be enabled, but the reading will not be valid. All of your parameter settings will be retained in the H2O or DataSonde 3 when the Scout 2 is disconnected or turned off.

PART SIX: Revised Battery Life Estimates

The estimated battery life for the Scout 2 has been revised. The following table gives the new battery life estimates for the Scout 2 System:

Sct 2 Configuration	Sct 2 Power Source Internal (hrs)	Hydrolab RBP-6AH (hrs)
DataSonde 3 Multiprobe Logger	10	32
DataSonde 3 <i>with Stirrer</i>	7.5	24
H20 Multiprobe	13.8	44.5
H20 Multiprobe <i>with Stirrer</i>	10	32

These battery life estimates assume an operating temperature of 25°C and a 100 meter cable length. The values will vary considerably with operating temperature, Stirrer condition, cable length, and brand of battery.

PART SEVEN: Helpful Notes

1. The Hydrolab H20 Multiprobe initially was restricted to communication at 1200 baud. In May, 1991, 300 baud and 2400 baud communication rates were added as user options on H20 software versions 1.02 or higher. The H20 must be set to communicate at 1200 baud before operation with the Scout 2. DataSonde 3s with software versions 1.22 or higher will also need to be set for 1200 baud communications before connection to the Scout 2.

2. The Scout 2 Display Unit cannot:

- calibrate the Label, Interval, and Message functions,
- access any of the DataSonde 3 Autolog or logging functions,
- change the baud rate, SDI-12 settings, or Conductivity ranging.

3. The Scout 2 will automatically enable the DataSonde 3 expert mode. To disable the expert mode when using a terminal or PC after using the Scout 2, refer to the DataSonde 3 Operating Manual.

4. Contact Hydrolab Customer Service for more information.

Scout® 2 Display Unit Operating Manual
ADDENDUM
September 1991

(upgrades Scout 2 Display Unit Operating Manual to Revision A)

This ADDENDUM replaces Section 3.12 (Changing the Scout 2 Display Unit Internal Batteries) for Scout 2 Data Display Units with revision B and higher.

Changing the Scout 2 Display Unit Internal Batteries

The display unit internal battery pack consists of a plastic holder containing 10 "AA" size batteries. You should generally use good quality alkaline type batteries to provide the longest service life. When the low battery indicator becomes activated (when the multiprobe battery reading drops below 10.0 volts) you should make plans to change the internal batteries (or recharge your external battery). The internal battery pack (when using alkaline cells) will operate your display unit and multiprobe with an attached Stirrer for at least 11.5 hours.

To change the internal batteries, begin first by disconnecting the underwater cable from the display unit and remove the display unit case from the bottom of the rubber boot. Use a Phillips screwdriver to remove the vent screw on the side of the case. The vent screw is used to relieve any pressure that may have accumulated in the case interior. Turn the case upside down on a soft pad (to avoid scratching the keyboard and display window) and use a flat-blade screwdriver to loosen the four screws on the bottom of the case. Loosen each screw a few turns then proceed to another screw to avoid undue stress on the case. When all four screws are loose, carefully move the bottom portion of the case to one side and disconnect the battery holder from the wiring harness. The battery holder is connected to the wiring harness using a small latching connector that is separated by pressing the retaining clip and pulling the two halves apart.

Remove the expired batteries and install 10 fresh "AA" alkaline batteries being very sure to note the polarity markings on the battery holder and that the batteries are firmly seated in the holder.

Do NOT install the batteries incorrectly, attempt to charge, or dispose of in fire. The battery may explode or leak causing material or bodily damage.

Reconnect the battery holder into the wiring harness by pushing the two connector halves together until the retaining clip engages. Carefully position the battery holder over the case and place the connector in the space at the end of the holder so that it will not be in the way when the screws are tightened. Tighten all four screws securely and install the vent screw. Tighten the vent screw until the o-ring just compresses against the case. Be careful not to damage the vent screw o-ring by using excessive force.

Do not forget to install the vent screw!

Replace the rubber boot by inserting the display unit case from the bottom and working the rubber boot around the case. Connect your multiprobe and verify proper operation. The battery reading from the multiprobe should now be about 15 volts.

When using an external power source for an extended length of time, you should always remove the internal batteries so that they will not be discharged. An error message will appear if you attempt to use an external power source when you have internal batteries installed. See Section 6.2.

Foreword

The Scout® 2 Display Unit performs with any Hydrolab Water Quality Multiprobe. These are the H20® Multiprobe, the DataSonde® Multiprobe Logger, the Reporter™ Multiprobe, and the 2" H20³G Multiprobe (for groundwater monitoring). The result is a portable, handheld system that can quickly perform short-term monitoring or sampling of water quality with no other equipment required.

A Hydrolab multiprobe measures **temperature**, **pH**, **dissolved oxygen** (both mg/L and percent saturation), **specific conductance** (milliSiemens/cm, microSiemens/cm), or **resistivity** (Kohms-cm), **turbidity** (NTUs), **salinity** (parts per thousand) or **total dissolved solids** (Kmg/L), **depth or level** (meters or feet), and **redox** (millivolts) in lakes, rivers, streams, process pipes, bays, estuaries, tanks, sewers, or other large or small water bodies.

The Scout 2 Display Unit formats the multiprobe data output onto an liquid crystal display that allows simultaneous, real-time viewing of up to six water quality parameters. The Scout 2 Display Unit is built into a rugged, handheld, waterproof package suitable for harsh field conditions.

Scout, H20, DataSonde, Reporter, and are all registered trademarks of Hydrolab Corporation.

Contents

Foreword	i
----------------	---

PART ONE: INTRODUCTION 1

1.1 Components and Assembly	1
Figure 1.1 Scout 2 System Components	3
1.2 Introductory Exercise	4
1.3 Display Unit Front Panel	6
1.4 The Multiprobe as a Stand-Alone Instrument	6
1.5 Important Note	6
Figure 1.2 Scout 2 Display Unit Panel Keys	7

PART TWO: DATA DISPLAY & MENUS 9

2.1 Data Display	9
2.1.1 Main Data Screen	9
2.1.2 Alternate Data Screen	11
2.1.3 Data Status Screen	12
2.2 Menus	13
2.3 The Menu Hierarchy	14
2.4 Calibrate	14
Figure 2.1 Scout 2 System Menu Tree	15
2.4.1 pH	16
2.4.2 Specific Conductance/Resistance	17
2.4.3 Salinity/TDS	18
2.4.4 Dissolved Oxygen	19
2.4.5 Barometric Pressure	20
2.4.6 Redox	20
2.4.7 Depth/Level	21
2.4.8 Time	21
2.5 Variables	22
2.5.1 Temperature	23
2.5.2 Specific Conductance/Resistivity	23
2.5.3 Dissolved Oxygen	24
2.5.4 Depth/Level	25
2.6 System	26
2.6.1 Label	27
2.6.2 Version	27
2.6.3 Swap	27
2.6.4 Contrast	28
2.7 Helpful Hints	29

PART THREE: MAINTENANCE and CALIBRATION 31

3.1 Caring for Your Multiprobe	31
3.2 Changing the Scout 2 Display Unit Internal Batteries	31

PART FOUR: DEPLOYMENT33

4.1 Deployment in Open Waters	33
4.2 Using the Stirrer	33
4.3 Pressure and Temperature Extremes	33
4.4 Performance Measurement and Improvement	33

PART FIVE: TECHNICAL NOTES35

5.1 Dissolved Oxygen Temperature and Salinity Corrections	35
5.2 The LoFlow Membrane Flow Optimization Factor	36
5.3 Dissolved Oxygen Altitude-Pressure Function	36
5.4 Specific Conductance	37
5.4.1 Temperature Standardization	37
5.4.2 Salinity Conversion	38
5.4.3 Resistivity Conversion	38
5.4.4 Total Dissolved Solids (TDS) Conversion	39
5.4.5 Correcting Depth for Specific Conductance	39
5.4.6 Measuring pH in Very Low Specific Conductance Waters	39
5.5 Turbidity	40
5.5.1 Measurement Principle	40
5.5.2 Ambient Light	40
5.5.3 Light Source Variation	40
5.6 Performance Measurement and Improvement	41

PART SIX: TROUBLESHOOTING43

6.1 General	43
1) Display Unit display is blank:	43
2) Parameter reading(s) are missing or incorrect	43
3) A calibration is not accepted	43
4) Dissolved Oxygen readings are too low to calibrate, and/or pH and/or redox readings are very high or very low:	44
5) Specific conductance, temperature, and/or depth readings seem wrong:	44
6.2 Scout 2 Display Unit Error Messages	44

PART SEVEN: LOGGING47

The DataSonde 3	47
Logging with a Personal Computer	47
Logging with Analog Voltage Output	47

APPENDICES

APPENDIX 1

Technical Data

Scout 2 Cable Pinouts

Scout 2 Connectors

Scout 2 Currents

ADDITIONAL INFORMATION

- Service Memorandum (quantity 3)



PART ONE: INTRODUCTION

1.1 Components and Assembly

Use *Figure 1.1* to identify the Scout[®]2 Display Unit, Hydrolab Water Quality Multiprobe, and the available battery and cabling options, as well as other parts of the Scout 2 System.

To assemble the Scout 2 System, begin by connecting the Underwater Cable to the Multiprobe. Be certain to note that the Multiprobe connector is keyed (one pin is larger than the others); do not force the connection. If you will be using the Hydrolab Stirrer, be sure to connect it to the 2 pin connector on the Underwater Cable as well. Then, connect the other end of the Underwater Cable (a six pin, metal shell connector) to the mating connector on the left side of the Display Unit. This is a twist-lock connection.

The Display Unit can operate using the included internal batteries or alternatively, an external battery may be used. The external battery can be Hydrolab's RBP-6AH rechargeable 12-volt gel cell or any other 12-volt battery. The external battery is connected to the Display Unit using the 4-pin are using a non-Hydrolab battery, use the AUX-PC Auxiliary Battery Cable; be sure to observe the polarity markings (red terminal is positive, black terminal is negative or ground). When using an external battery you should remove the internal batteries from the Display Unit so that they will not be discharged (an error message will be displayed if you have both power sources connected). See Section 3.12 for information on how to remove and install the Scout 2 internal batteries.

WARNING: CONNECTION OF HYDROLAB INSTRUMENTATION TO ANY POWER SOURCE THAT IS IN ANY WAY CONNECTED TO A VOLTAGE SOURCE RATED OVER 18 VOLTS CAN RESULT IN ELECTROCUTION THAT CAN KILL YOU. DO NOT USE A TRANSFORMER THAT PLUGS INTO THE WALL TO PRODUCE A LOW-VOLTAGE SUPPLY. USE ONLY BATTERIES THAT PRODUCE A TOTAL VOLTAGE OF LESS THAN 18 VOLTS DC.

Press the On/Off key (in the lower right corner of the Display Unit panel) to verify operation of your Scout 2 System. You should immediately see a start-up message followed by a data display. The Multiprobe is now continuously sending data to the Display Unit for presentation on the liquid crystal display. Press the On/Off key again to turn off the Display Unit. (The Display Unit On/Off key controls power to the Multiprobe as well as the Display Unit itself). If you are unable to get your Scout 2 System to operate correctly, please refer to Part Six.

Please refer to the H20, H20G or DataSonde Water Quality Multiprobe Operating Manual for further details on the operation of any specific Multiprobe options that you may have.

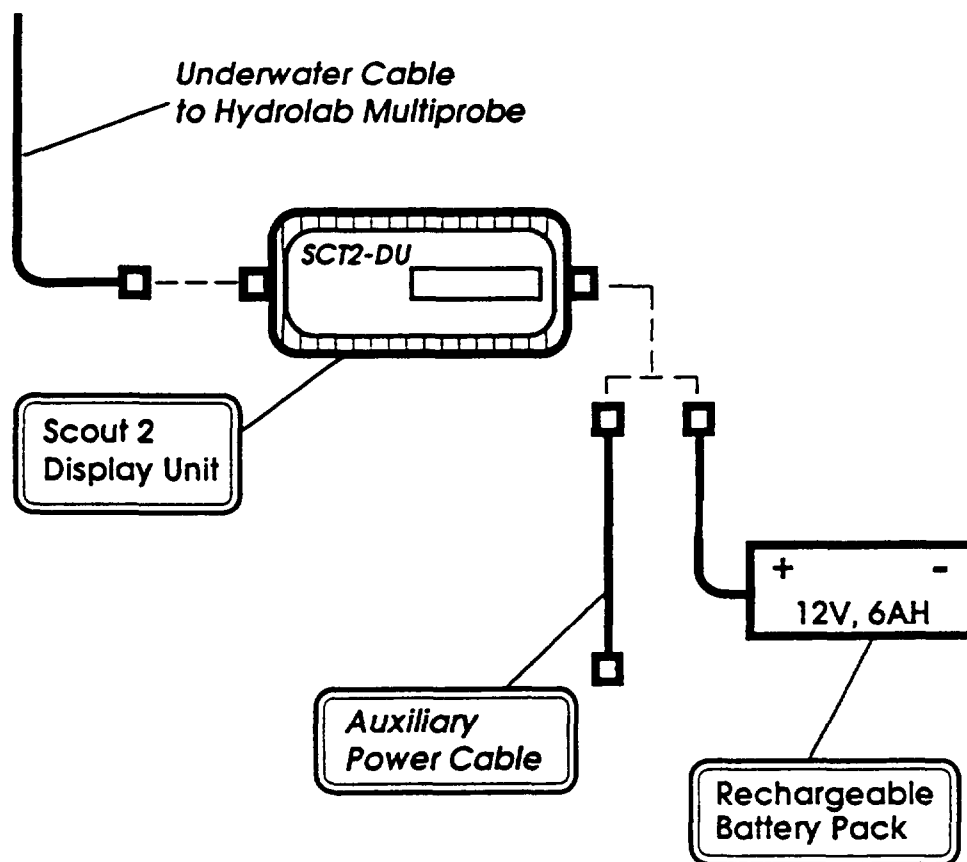


Figure 1.1 Scout 2 System Components

1.2 Introductory Exercise

In order to acquaint you with the basic display unit operation, suppose we are going to calibrate specific conductance and then go to the lake to make some measurements.

Turn the assembled Scout 2 on by pressing the On/Off key. You will see the following message:

SCOUT 2, V.1.00
(C)1991, Hydrolab

After a few seconds, the start-up message will be replaced by the Main Data Screen. The Main Data Screen displays six multiprobe readings indicated by the display unit panel icons. If a previous operator had utilized the Alternate Data Screen, then a group of four multiprobe readings will be displayed that are identified by units characters (see Section 2.2). Return to the Main Data Screen by pressing the Screen/Escape key.

To calibrate the multiprobe specific conductance readings to a known standard value, fill the calibration cup with a prepared standard solution for which the specific conductance is precisely known. For this example assume we have a solution prepared that has a specific conductance of 1.417 milli-Siemens/cm. (See Part Three for further calibration details). When the specific conductance readings have stabilized (this might require one or two minutes), press the Calibrate key to enter the Calibrate menu as follows:

Calibrate
PCS%OARDT: PH

The cursor is flashing on the first letter P, for pH, so use the right-pointing arrow key to move the cursor over one space to the letter C to get:

Calibrate
PCS%OARDT: Sp Cond

When you have obtained the proper menu selection, press the Enter key to begin the specific conductance calibration sequence. You will see the following screen:

Calibrate
Sp Cond 1.425

The bottom line of the display will show you that specific conductance is currently being calibrated and that the last available reading from the Multiprobe was in this example, 1.425. The cursor will be flashing on the first digit of the Multiprobe reading. The last two significant digits will need to be changed from 25 to 17 to make the specific conductance reading match our calibration standard. Press the right-pointing arrow key twice to move the flashing cursor to the second least significant digit (the 2). Then press the downward-pointing arrow key to change the selected 2 to a 1 to get:

Calibrate
Sp Cond 1.415

To set the last digit, press the right arrow key once more to move the cursor right one space in the value to select the least significant digit (the 5). This time, use the upward-pointing arrow key to change the digit from a 5 to a 7 to get the following value:

Calibrate
Sp Cond 1.417

Since this is now the value of the calibration solution, press the Enter key to continue. Next you will be asked if you really want to save this calibration:

Save New CAL
YN: No

Since the cursor is flashing on the letter N, for No, use the right or left arrow key to select the Y or Yes option:

Save New CAL
YN: Yes

Press the Enter key again to fix the calibration value (the start-up message will be displayed during this time). The Display Unit automatically requests a specific conductance calibration sequence and sends the new specific conductance value to the Multiprobe. If a valid calibration was accomplished, then the Scout 2 will return to either the Main Data Screen or the Alternate Data Screen after a few seconds. However, if the calibration could not be accomplished, then an error message will be momentarily displayed:

CAL out of Range

The Display Unit will then return to the data display screen after a few seconds. Note that any of the above menu sequences can be cancelled and the data display screen returned by pressing the Screen/Escape key.

The Scout 2 System is now ready to go to the lake and perform some specific conductance measurements for you. You can freely turn the power on or off without losing calibration which will remain in effect until changed by another calibration sequence. When the Multiprobe has been lowered into place in the lake water, the specific conductance can be read directly from the Display Unit.

1.3 Display Unit Front Panel

The Display Unit front panel consists of a 2 line by 20 characters per line liquid crystal display and a nine position keyboard as shown in *Figure 1.2*. The display provides all information and prompting to the operator. The keyboard is used to alter the Display Unit operating modes as well as the Multiprobe operating modes and calibration settings.

1.4 The Multiprobe as a Stand-Alone Instrument

The Multiprobe is a very powerful instrument that can be operated in a variety of configurations. For example, the Multiprobe can be used directly with a computer or terminal device other than the Display Unit. A DataSonde Multiprobe may be left unattended to take measurements remotely and store data in its internal logger for later downloading. Be certain to read the Multiprobe Operating Manual in order to utilize the full potential of your Multiprobe.

1.5 Important Note

Although you have now performed several of the basic operations available from the Scout 2 System, please read Part Two to discover the System's other features. Also be sure to read Part Three, since only a well maintained and carefully calibrated instrument will provide quality data.

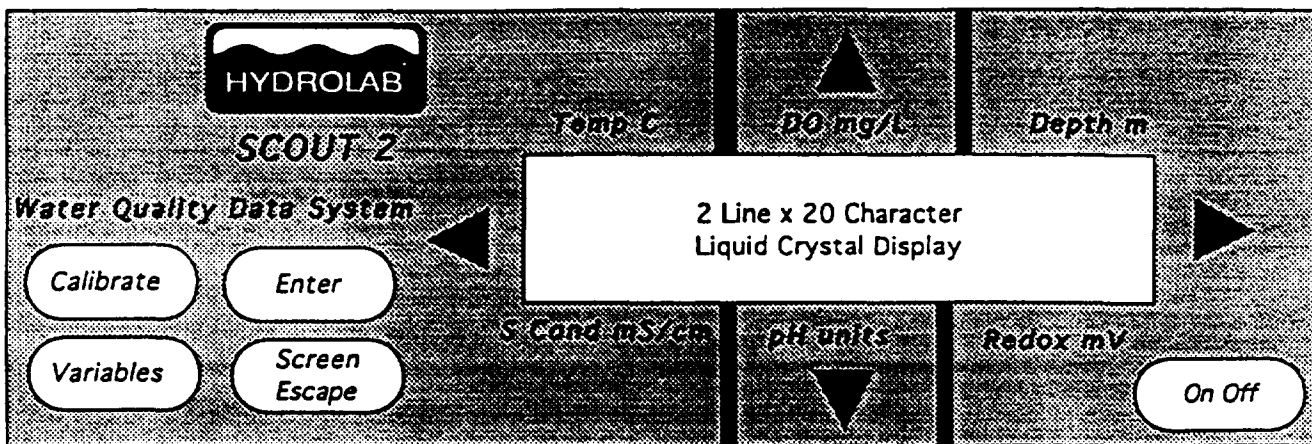


Figure 1.2 Scout 2 Display Unit Panel Keys

The remainder of this manual, although primarily reference material, should also be read.

1.6 Performance Manual

You will find at the end of this manual, a copy of Hydrolab's *"Performance Manual for Field Water Quality Instrumentation"*. This article contains many helpful hints for both qualifying and improving the reliability of your data. You might be surprised to find out what your Hydrolab instrument can really do.



PART TWO:

DATA DISPLAY & MENUS

When the Display Unit is turned on (by pressing the On/Off key), a start-up message that includes a copyright notice and the installed software revision number appears on the liquid crystal display. During this time, the Display Unit interrogates the attached Multiprobe to determine the configuration of the instrument. An error message will be displayed if a valid Multiprobe is not connected. (See Section 6.2 for information on specific error messages). Other error messages may be displayed as appropriate. If all of the Multiprobe readings are not enabled, then the Display Unit will execute a Multiprobe command sequence that will result in the transmission of all available readings. All of the Multiprobe readings will remain enabled until you execute a change using a PC or terminal. No other variables or settings stored in the Multiprobe are modified at this time.

After the Display Unit has determined the configuration of the Multiprobe, a data screen will automatically appear in which readings taken from the Multiprobe are continuously displayed and updated (about once per second). The Multiprobe readings are displayed on one of two data screens selected by the Screen/Escape key. This key toggles the liquid crystal display between a Main Data Screen and an Alternate Data Screen. The Main Data Screen displays the major six water quality readings from the Multiprobe and the Alternate Data Screen shows the remaining four Multiprobe readings.

2.1 Data Display

2.1.1 Main Data Screen

The Main Data Screen shows Temperature (°C), DO (mg/L) and Depth (meters) across the top line and Specific Conductance (milliSiemens/cm), pH, and Redox (mV) across the bottom line. The front panel icons indicate the units of the default Multiprobe readings on the main display screen. The Multiprobe readings are organized as shown below in an example:

25.00	16.83	100.3
0.500	7.35	1346

If the sensor for a particular Multiprobe reading is not installed, then the Display Unit will show a dot string in that display location as follows:

25.00	16.83	100.3
0.500	7.53

In this example, the redox sensor was not installed in the Multiprobe at the time of manufacture.

The Multiprobe has numerous options that allow you to alter the units of the readings to fit your particular circumstances and preferences. For example, temperature can be displayed in °C (default units) or in °F. Any Multiprobe readings that have units different from those shown on the front panel are identified by a unit code that appears on the end of the data value. The unit codes for the default Main Data Screen are:

°F	Temperature, °F
μS	Specific Conductance, microSiemens/cm
kΩ	Resistivity, kilohms-cm
'	Depth, feet

For example, if the Multiprobe is sending temperature readings in degrees Fahrenheit and resistivity instead of conductance measurements, then the Main Data Screen will appear as shown below:

77.0°F	16.83	100.3
2.0kΩ	7.53

Note the unit suffix codes for the temperature and resistivity readings.

The specific conductance reading can be optionally replaced by the salinity reading that normally resides on the Alternate Data Screen. The specific conductance reading can then be found on the Alternate Data Screen. Also, the redox reading on the Main Data Screen can be interchanged with the Multiprobe Battery reading normally found on the Alternate Data Screen. These two data display customization options allow you to configure your Display Unit to minimize screen switching in most water quality measurement situations. Refer to Section 2.6.3 for details on data display customization.

2.1.2 Alternate Data Screen

The default Alternate Data Screen shows salinity and the battery readings across the top line and DO %sat and the time reading across the bottom line. The units shown on the front panel are now no longer valid and are replaced by unit codes that appear as suffixes on the Multiprobe readings. The unit codes for the default Alternate Data Screen are shown below:

ppt	Salinity, parts/thousand
V	Battery, volts
%sat	DO, percent saturation
g/L	TDS, grams/liter
:	Time, HH:MM

If the Multiprobe is set to take salinity readings, then as an example, the Alternate Data Screen will appear as:

0.0ppt	12.0V
0.0%sat	01:59

Note that the Multiprobe time reading is formatted as HH:MM and the seconds are not displayed. In the above example, the Multiprobe elapsed time is read as one hour and 59 minutes.

When the Multiprobe battery reading drops below 10.0 volts, then the Scout 2 adds a low battery warning symbol to the reading in the Alternate Data Screen as follows:


0.0ppt	9.9V 
0.0% sat	01:59

The Scout 2 internal batteries should be replaced or the external battery recharged as soon as possible after the low battery warning symbol appears for optimum system performance.

Please refer to Section 2.6.3 for details on user modification of the Alternate Data Screen.

2.1.3 Data Status Screen

The Main and Alternate Data Screens do not show the calibration and compensation status characters that are normally provided by the Multiprobe. (Refer to the Multiprobe Operating Manual for details on the data status characters). This status information can be viewed on the Display Unit by pressing the downward-pointing arrow key when either of the two data display screens are active. In addition to the calibration and compensation status, the Data Status Screen shows the current power source for the Display Unit. For example, if the Display Unit is using internal batteries, and the Multiprobe depth reading is uncalibrated, then the Data Status Screen will appear as follows:

H2O: P_ C_ S_ O_
%_ R_ D* B_ T_  Int

Note that the data status characters follow a Multiprobe reading indicator that identifies a particular Multiprobe data value. The Multiprobe reading indicators follow the notation utilized by the Multiprobe with the exception of the time reading which is denoted by the letter T on the Display Unit. (The letter T indicates the temperature reading on the Multiprobe, however, the temperature reading is always calibrated and compensated and is not included in the Data Status Screen). The Multiprobe reading indicators are as follows:

P pH
C Specific Conductance (or Resistivity)
S Salinity (or TDS)
O Dissolved Oxygen, mg/L
% Dissolved Oxygen, % Saturation
R Redox
D Depth (or Level)
T Time

The data status characters that follow the reading indicators and are summarized below:

_ Data is OK (nothing to report)
• Data is uncalibrated
@ Data is not temperature or salinity compensated
*@ Data is uncalibrated and uncompensated
Data is over-ranged
x Data probe is not installed

The status of the Scout 2 battery operation is indicated as follows:

- ☐ Int Scout 2 is on internal power
- ☐ Ext Scout 2 is on external power

The main or Alternate Data Screen will resume automatically if any key is pressed or if 10 seconds elapses.

For another example, the Data Status Screen shown below,

H2O: P# C* S* O__
%__ Rx Dx B__ T__ <input type="checkbox"/> Ext

is interpreted as follows:

- pH is over-ranged
- conductance and salinity are both uncalibrated and uncompensated
- dissolved oxygen, battery and time readings are OK
- redox and depth sensors are not available
- Scout 2 Display Unit is on external power

2.2 Menus

Due to the limited keyboard available on the Display Unit front panel, most of the keys activate multiple functions. When the Display Unit is actively displaying Multiprobe data, the Screen/Escape key will toggle between the Main and Alternate Data Screens, however, if you are in any Scout 2 System menu structure, then this same key will return you to the Data Screens. There are also four arrow keys that are used to manipulate data and menu selections or to execute auxiliary functions from the data display screens. When working in a Scout 2 System menu structure, the left and right arrow keys move the cursor between successive menu selections and the up and down arrow keys are used to change selected digits when entering a calibration value. The up and down arrow keys will also allow you to scroll up or down through a menu sequence to determine the current settings without inadvertently changing anything. The Enter key is used to fix any or all menu selections or calibration value entries.

2.3 The Menu Hierarchy

The Scout 2 System menu tree structure is outlined in *Figure 3.1*. The Display Unit has three basic or top-level menu structures that can be accessed from the front-panel keyboard. These menus allow you to set or view the Multiprobe variables, conduct calibration sequences for the Multiprobe readings, and also allow you access to some miscellaneous Scout 2 System functions. The menus are detailed in Sections 2.4 through 2.6.

2.4 Calibrate

The Scout 2 System Calibrate menu allows you to calibrate the Multiprobe readings using known standard solutions. Please refer to Part Three or the Multiprobe Operating Manual for specific details on calibrating your Multiprobe. This section describes the Scout 2 calibration and standard value entry screens used to calibrate a Multiprobe. The known solution should be placed in the Multiprobe Calibration Cup and the Multiprobe reading should be monitored on the data display screen until the reading stabilizes. The Calibrate menu can then be accessed by pressing the Calibrate key on the Display Unit front panel. The data display screen is replaced by the top-level Calibrate menu as follows:

Calibrate
PCS%OARDT: PH

The Calibrate menu options can be viewed by pressing the left or right arrow keys. These keys move a flashing cursor through the menu string on the left and the current selected menu option is shown on the right. The nine menu options are listed below:

- P: pH
- C: Specific Conductance/Resistivity
- S: Salinity/TDS
- %: Dissolved Oxygen (% Saturation)
- O: Dissolved Oxygen (mg/L)
- A: Barometric Pressure
- R: Redox
- D: Depth/Level
- T: Time (absolute or elapsed)

Select a Calibrate menu option by moving the flashing cursor to the desired location and press the Enter key. Each of these selections are de-

See
ADDENDUM C
in the front of this manual
for latest version.

scribed in Sections 2.4.1 through 2.4.8. The Multiprobe temperature and battery voltage parameters are permanently set at the factory and do not require user calibration.

When you select a Multiprobe parameter to calibrate, the last available Multiprobe reading for that parameter is displayed (with the exception of DO % saturation). The displayed reading should be close to the known value of the standard solution. If the reading is correct, just press the Enter key. If not, the value can be modified using the four arrow keys as follows: the left and right arrow keys move the cursor back and forth across the digits (decimal points are automatically skipped) and the up and down arrows allow you to increment or decrement the selected digit. You can also modify the sign of the redox or depth/level readings during the calibration sequence.

When the value is correctly adjusted, use the Enter key to send the calibration value to the Multiprobe. The Display Unit asks if you really want to go ahead with the calibration; select the Y (for yes) option and press the Enter key again to proceed with the calibration. The Multiprobe has built-in checks for calibration acceptability. If the calibration value you enter is too far out of bounds, you will see a message that the calibration was out of range and the data display screen will resume. If you are unable to calibrate a Multiprobe reading, verify the quality of your standard solution and check the condition of the Multiprobe sensor. See Part Three for further details.

Calibration points are remembered by the Multiprobe even if the Display Unit is turned off. There is no need to recalibrate each time the Multiprobe is turned on, and any Multiprobe can be connected to any Display Unit without recalibration.

If you try to calibrate an Multiprobe reading for which there is no sensor installed then you will get a brief error message before the data display screen is resumed (see Section 6.2).

2.4.1 PH

Always calibrate your Multiprobe using a buffer solution near pH 7 (the pH system's zero point) before calibrating with a second buffer (the pH system's slope). Any pH value between 6.8 and 7.2 may be used for the zero setting; all other pH values may be used to calibrate the slope.

After the reading for your 7-buffer solution stabilizes, select P from the Calibrate menu to begin the pH calibration:

Calibrate
PH: 7.01

The cursor will be flashing over the '7' digit in the value. If your buffer is exactly 7.00, press the right arrow key twice to place the cursor over the '1' digit. Next press the down arrow key to decrement the '1' digit to a '0' digit and press the Enter key. (Remember that the Screen/Escape key will return you to the data display screen at any time). The pH Calibrate screen will be replaced by:

Save New Cal?
YN: No

Select Y and press the Enter key to set the pH system zero point and return to the data display screen.

To set the slope for the Multiprobe pH system, use the same calibration sequence as described above except replace your 7-buffer solution with a slope buffer solution (such as 9.18 or 4.02 units) and adjust the Multiprobe reading to match that of your slope buffer solution.

2.4.2 Specific Conductance/Resistance

You can calibrate either specific conductance or resistivity, or salinity or TDS, but you cannot calibrate any two of these parameters independently since they are all measured using the same sensor. If you calibrate specific conductance, then resistivity, salinity, and TDS are automatically calibrated as well. If you then calibrate, for example, salinity, then the salinity calibration is translated into a new calibration for specific conductance, resistivity, and TDS. The original specific conductance calibration is lost. So pick from those four measurements the parameter of the greatest interest and calibrate that parameter directly. Refer to Part Five for the mathematical details involved.

Monitor the specific conductance reading on the Display Unit data display screen until the reading stabilizes to the value for the standard solution in which the sensor is immersed. Select C from the Calibrate menu to begin the calibration:

Calibrate
Sp Cond 0.383

The displayed reading should be close to the known value of the standard solution. Adjust the reading to be equal to the known solution value using the four arrow keys. Press the Enter key when the value is properly adjusted and select Y to the Save Cal question to complete the calibration.

Had you decided to measure resistivity instead of specific conductance by choosing resistivity over specific conductance in the Variables menu, you would now be required to enter the calibration value using the resistivity units even though the calibration menu states that you are calibrating specific conductance.

2.4.3 Salinity/TDS

You can calibrate either specific conductance or resistivity, or salinity or TDS, but you cannot calibrate any two of these parameters independently since they are all measured using the same sensor. If you calibrate specific conductance, then resistivity, salinity, and TDS are automatically calibrated as well. If you then calibrate, for example, salinity, then the salinity calibration is translated into a new calibration for specific conductance, resistivity, and TDS. The original specific conductance calibration is lost. So pick from those four measurements the parameter of the greatest interest and calibrate that parameter directly. Refer to Part Five for the mathematical details involved.

Monitor the salinity reading on the data display screen until the reading stabilizes to the value for the standard solution in which the sensor is immersed. Select S from the Calibrate menu to begin the calibration:

<p>Calibrate Salinity 40.00</p>

The displayed reading should be close to the known value of the standard solution. Adjust the reading to be equal to the known solution value using the four arrow keys. Press the Enter key when the value is properly adjusted and select Y to the Save Cal question to complete the calibration.

Had you decided to measure TDS instead of salinity by choosing TDS over salinity in the Variables menu, you would now be required to enter the calibration value using the TDS units even though the calibration menu states that you are calibrating salinity.

2.4.4 Dissolved Oxygen

The two dissolved oxygen functions, DO (mg/L) and DO (% saturation) cannot be calibrated independently. Instead, choose % saturation if you wanted to calibrate to atmospheric conditions (i.e., the traditional "air cal"). The Multiprobe calculates the calibration value from a solubility table, ambient temperature, and barometric pressure.

Choose DO (mg/L) to input a special calibration (for instance, a Winkler titration value) that is different from the value that would be calculated by the Multiprobe in the % saturation mode.

Set up the dissolved oxygen (DO) sensor as required for calibration (detailed in Part Three) and wait for a stable reading. Select % from the Calibration menu to get:

Calibrate DO %SAT 760.0

The reading displayed opposite "DO %SAT" is the last entered barometric pressure value in millimeters of mercury. (For instance, 760 is the sea level value). Check your barometer or weather bureau to see if you need to modify this value. Be sure to convert your barometer or weather bureau readings to the proper units (mm Hg) and to compensate for your local altitude before entering the new value (see Section 5.3). Use the right and left arrow keys to select a digit to modify and the up and down arrow keys to modify the selected digit. Press the Enter key when the value is properly adjusted and select Y to the Save Cal question to complete the calibration.

Check the results of the calibration by looking at the DO % saturation reading (on the Alternate Data Screen); it should be 100.0 for the Standard membrane, or 102.5 for the Hydrolab LoFlow™ membrane (see Section 3.7). You should read Appendix 1 to see how this number correlates to DO concentration (i.e., mg/L).

Alternatively, select O from the Calibrate menu to get:

Calibrate DO mg/L 08.24

Now adjust the displayed DO value to match that of the calibration standard as you have measured it with a Winkler titration or another lab instrument. Press the Enter key when the value is properly adjusted and select Y to the Save Cal question to complete the calibration.

This calibration sequence uses the barometric pressure value entered using the barometric pressure calibration sequence described in Section 2.4.5. Be sure to check this value before conducting the DO concentration calibration.

2.4.5 Barometric Pressure

You can change the barometric pressure value that is used to correct the dissolved oxygen readings to more closely match the current environmental conditions. The default barometric pressure value is fixed to 760.0 (sea level) millimeters of mercury. Select A from the Calibration menu to modify this value (default is the sea level or 760.0 value):

Calibrate Atm Press 760.0
--

The reading displayed opposite "Atm Press" is the last entered barometric pressure value in millimeters of mercury. Check your barometer or weather bureau to see if you need to modify this value. Be sure to convert your barometer or weather bureau readings to the proper units (mm Hg) and to compensate for your local altitude before entering the new value (see Section 5.3). Use the right and left arrow keys to select a digit to modify and the up and down arrow keys to modify the selected digit. Press the Enter key when the value is properly adjusted and select Y to the Save Cal question to complete the calibration.

2.4.6 Redox

To calibrate the Multiprobe redox reading (also known as ORP or Eh), select R from the Calibrate menu to begin:

Calibrate Redox 500

The reading displayed opposite "Redox" is the last available Multiprobe redox reading in millivolts. Note that redox readings are inherently slow to equilibrate so allow extra time for this calibration. When you need to modify this value to match the known value of your redox solution then use the right and left arrow keys to select a digit to modify and the up and down arrow keys to modify the selected digit. Press the Enter key when the value is

properly adjusted and select Y to the Save Cal question to complete the calibration.

2.4.7 Depth/Level

To calibrate the Multiprobe depth or level sensor, place the Multiprobe at a known depth (you can use "zero" depth at or near the water surface) and select D from the calibrate menu:

Calibrate Depth 000.0
--

The reading displayed opposite "Depth" is the last available Multiprobe depth or level reading. If you need to modify this value to match the known location of your Multiprobe then use the right and left arrow keys to select a digit to modify and the up and down arrow keys to modify the selected digit. Press the Enter key when the value is properly adjusted and select Y to the 'Save Cal' question to complete the calibration.

Had you decided to measure depth or level in feet instead of meters by choosing feet over meters in the Variables menu, you would now be required to enter the calibration value in feet.

2.4.8 Time

Select T from the Calibrate menu to modify the Multiprobe time function:

Calibrate Time 122435
--

The reading displayed opposite "Time" is the last available Multiprobe time reading. If you need to modify this value then use the right and left arrow keys to select a digit to modify and the up and down arrow keys to modify the selected digit. Press the Enter key when the value is properly adjusted and select Y to the Save Cal question to complete the calibration.

Use the military time format when setting the Multiprobe time; for example, if you want to set the time to 5:30 in the morning then you would adjust the displayed time value to 053000. Numbers greater than 59 in the

minutes or seconds positions or numbers greater than 23 in the hours position will generate a "CAL out of Range" message. Be sure to check the data display screen (Alternate Data Screen) to make sure that the time reading is correct.

Note that the Display Unit does not display the "seconds" portion of the Multiprobe time value on the Alternate Data Screen, but that you can calibrate the time reading down to the "seconds" resolution.

2.5 Variables

The Multiprobe has a large number of user modifiable features (known as variables) that allow adaptation to various measurement situations. These variables are stored in a non-volatile fashion in the Multiprobe so that they are retained even if the Display Unit is turned off. The Multiprobe variables can be accessed in the Scout 2 System using the Variables menu. The Variables menu is accessed by pressing the Variables key on the Display Unit front panel. The data display screen is replaced by the top-level Variables menu as follows:

Variables
TCOD: Temperature

The Variables menu options can be viewed by pressing the left or right arrow keys. These keys move a flashing cursor through the menu string on the left and the current selected menu option is shown on the right. The four Variables menu options are listed below:

- T: Multiprobe Temperature variable
- C: Multiprobe Specific Conductance/Resistivity variables
- Q: Multiprobe Dissolved Oxygen variables
- D: Multiprobe Depth variables

Select a Variables menu option by moving the flashing cursor to the desired location and press the Enter key. Each of these selections have one or more submenus that are described in Sections 2.5.1 through 2.5.4.

2.5.1 *Temperature*

Select T from the Variables menu to enter the Temperature Variable menu:

T Variable
CF: °F

The flashing cursor is positioned to the current Multiprobe setting (degrees Fahrenheit in this case). Move the cursor to C if you wish to change the Multiprobe temperature units to degrees Centigrade or to F if wish the temperature units to be in degrees Fahrenheit. Press the Enter key to store the new setting in the Multiprobe and return to the data display mode. Remember that if you do not want to change the temperature variable at this point, press the Screen/Escape key or the down arrow key to return to the data display mode. Any selected menu option will then be discarded. Pressing the up arrow key will return you to the Variables menu for another selection.

2.5.2 *Specific Conductance/Resistivity*

The Specific Conductance/Resistivity Variables menus will lead you through a series of five variables that you can choose to modify or skip. Again, the flashing cursor is positioned to the current Multiprobe settings. The current variable settings can be viewed by using the down arrow key. Pressing the down arrow key at the last or fifth variable will return you to the data display mode without any changes being performed. Pressing the up arrow key from the first variable position will return you to the Variables menu for a new selection. Any desired variable modifications must be fixed using the Enter key on each of the five variables in this menu. Pressing the Screen/Escape key at any time will return you to the data display screen.

Selecting a C from the Variables menu will produce the following submenu:

C Variables
CR: Resistivity

Select C if you wish to measure specific conductance instead of resistivity. Select R otherwise. Press the Enter key to fix the new selection and to continue to the next variable:

C Variables
MU: MicroSiemens

Select M if you want your data reported in milliSiemens/cm or a U if you need microSiemens/cm. Press Enter to continue:

C Variables
FS: Salt Water

Select F if your Multiprobe is equipped with a freshwater Cell Block or select S if it has a saltwater Cell Block (Section 3.4). Press Enter to continue:

C Variables
TS: TDS

Select S if you wish to display salinity instead of TDS. Select T otherwise. Press Enter to continue:

C Variables
UT: Temp Comp

Select U if you want your specific conductance/resistivity and salinity/TDS readings to be reported without reference to 25°C. Select T otherwise. Press Enter to set all of these specific conductance/resistivity variables and return to the data display mode.

You might have noticed that the Multiprobe has an additional specific conductance/resistivity variable that controls the ranging of the readings. This variable is not included in the Display Unit and cannot be modified using the Scout 2 System. This variable is mainly used to modify the specific conductance/resistivity data for use with data collection platforms and certain types of data recorders. This variable remains at the setting previously stored in the Multiprobe. Consult the Multiprobe Operating Manual for the details of this variable.

2.5.3 Dissolved Oxygen

The Dissolved Oxygen Variables menu will lead you through a series of two variables that you can choose to modify or skip. Again, the flashing cursor will be positioned to the current Multiprobe settings. The current variable settings can be viewed by using the down arrow key. Pressing the down arrow key at the last or second variable will return you to the data

display screen without any changes being performed. Pressing the up arrow key from the first variable position will return you to the Variables menu for a new selection. Any desired variable modifications must be fixed using the Enter key on each of the two variables in this menu. Pressing the Screen/Escape key at any time will return you to the data display screen.

Select O from the Variables menu to modify or view the Multiprobe DO variables:

O Variables
SL: LOFLOW

Select S if you are using a Standard membrane, or select L if you are using a LoFlow membrane and its helper software (see Section 3.7 or Appendix 1 for more explanation). Press Enter to continue:

O Variables
SU: Salt Uncomp

Select S if you want your DO (mg/L) readings to be compensated for the effect of sample salinity or select U otherwise. Press Enter to set these variables and return to the data display screen.

2.5.4 Depth/Level

The Depth/Level Variables menu will lead you through a series of two variables that you can choose to modify or skip. As before, the flashing cursor is positioned to the current Multiprobe settings. The current variable settings can be viewed by using the down arrow key. Pressing the down arrow key at the last or second variable will return you to the data display mode without any changes being performed. Pressing the up arrow key from the first variable position will return you to the Variables menu for a new selection. Any desired variable modifications must be fixed using the Enter key on each of the two variables in this menu. Pressing the Screen/Escape key at any time will return you to the data display screen.

Select D from the Variables menu to modify or view the Multiprobe depth/level variables:

D Variables
MF: Feet

Select M if you want your depth or level readings displayed in meters; select F if you work in feet. Press Enter to continue:

D Variables DL: Depth
--

Select D if your Multiprobe is equipped with a depth transducer (range: 0 to 100 meters). Select L if your Multiprobe is equipped with a level transducer (range: 0 to 10 meters). The transducer type is printed on the Multiprobe's label. Press Enter to set these two variables and return to the data display screen.

2.6 System

The Scout 2 System menu is a collection of functions that allow you some data display options as well as viewing of your Multiprobe Label contents and software revision. The Scout 2 System menu is invoked from a data display screen by pressing the up-arrow key. The data display screen is replaced by the top-level System menu:

System Menu LVSC: Label
--

The System menu options can be viewed by pressing the left or right arrow keys. These keys move a flashing cursor through the menu string on the left and the current selected menu option is shown on the right. The four System menu options are listed below:

- L: Label - Show the current Multiprobe Label contents
- V: Version - Show the Multiprobe and Scout 2 software revision
- S: Swap - User customization of the data display screens
- C: Contrast - Modify the Scout 2 liquid crystal display contrast

Select a System menu option by moving the flashing cursor to the desired location and press the Enter key. Each of these selections have one or

more submenus that are described in Sections 2.6.1 through 2.6.4.

2.6.1 Label

Select L from the System menu to display the contents of your Multiprobe Label. The Label typically contains your Multiprobe serial number. The default Label for a Multiprobe is shown below:

Label NO LABEL

The Label is displayed for about 5 seconds (or until you press any key) before the data display screen is resumed.

The Scout 2 does not have any provision to allow you to alter the contents of your Multiprobe Label. Please consult your Multiprobe Operating Manual for further details.

2.6.2 Version

Select V from the System menu to display the current software revision numbers for your Scout 2 System. Please note these software revision numbers when you need to contact Hydrolab concerning your Scout 2 System. This function returns the revision number for the Display Unit software and the revision number for the particular H20 Multiprobe that is connected:

SCOUT 2:	1.00
H20:	1.02

The revision numbers are displayed for about 5 seconds (or until you press any key) before the data display screen is resumed.

2.6.3 Swap

The Swap function allows you to customize your Scout 2 data display screens by moving the Multiprobe salinity reading from the Alternate Data Screen to the Main Data Screen where it would replace the Multiprobe

specific conductance reading. The specific conductance reading is then moved to the old salinity position on the Alternate Data Screen. The Multiprobe battery reading can also be moved from the Alternate Data Screen to the redox reading position on the Main Data Screen. The redox reading can then be found on the Alternate Data Screen in the old battery value position. Since the units of the swapped Multiprobe readings will no longer match the Display Unit front panel icons, unit codes will be added to the readings as follows:

- s Salinity on Main Data Screen (ppt)
- g TDS on Main Data Screen (g/L)
- mv Redox on Alternate Data Screen (millivolts)
- mS Specific Conductance (milliSiemens/cm) on Alternate Data Screen
- k Ω Resistivity on Alternate Data Screen (kilohms-cm)
- V Battery on Main Data Screen (volts)
- μ S Specific Conductance (microSiemens/cm) on either data screen

Select S from the System menu to begin the Swap function:

SAL on Main
YN: NO

Use the right arrow key to select Y for yes and press the Enter key:

BATT on Main
YN: NO

Use the right arrow key to select Y for yes and press the Enter key to execute the changes and return to the data display screens. Note that you have the option of executing one or both of the display modifications. Remember that if you press the Screen/Escape key before you press the Enter key you will exit the System menu without any changes.

The modified data display screens will remain in effect until you change them again or if the Display Unit loses all power for longer than 25 minutes.

2.6.4 Contrast

The Contrast function allows you to adjust the contrast (brightness) of the Display Unit liquid crystal display to compensate for ambient air temperature or viewing angle effects. As the ambient temperature gets colder you may find that

increasing the display contrast will improve the readability of the display. You may also need to adjust the contrast to improve the brightness of the display based on the position of the display when you observe the readings. Some experimentation here will allow you to observe the effect of viewing angle on display brightness. The default contrast setting (as shipped from the factory) is optimized for most measurement circumstances but if you would like to modify the display contrast then select C from the System menu:

Set Contrast
Min|| || || || || ||. . . Max

The display contrast will increase or decrease by one step each time you press the right or left arrow key, respectively. The bar graph display shows you the relative amount of adjustment. You might notice that you can decrease the contrast to the point where the display completely disappears; just use the right arrow key to increase the contrast or press the Screen/Escape key to return to the data display screens without changing the contrast.

When you find the optimum contrast setting, press the Enter key to fix the new setting. You are first asked if you really want to change the contrast as follows:

Set Contrast
YN: No

Select Y (for yes) and press the Enter key again to complete the contrast adjustment and return to the data display screen. The display contrast will remain in effect until you change it again or if the Display Unit loses all power for longer than 25 minutes.

2.7 Helpful Hints

Remember that any time you want to exit any Scout 2 System menu without changing any settings, just press the Screen/Escape key. You will be returned automatically to the Main or Alternate Data Screen (whichever screen was active when you entered the menu) as if you never entered the menu at all. You must use the Enter key to complete any menu activity or calibration value adjustment.

You must also keep your Multiprobe sensors clean and well maintained. Calibration of a neglected sensor is in most cases a waste of time. Remember to check the Data Status Screen (Section 2.1.3) and the data display screen to confirm that the new calibration value is in effect.



PART THREE:

MAINTENANCE and CALIBRATION

3.1 Caring for Your Multiprobe

Please read your multiprobe's operating manual for detailed instructions on maintenance and calibration.

Note: Remember that the calibration points for a Scout 2/multiprobe system are stored in the multiprobe. This allows one display unit to calibrate several multiprobes if those multiprobes are to be used later without a display unit (for instance, unattended logging, or attached to a PC). It also means that any multiprobe can be used with any display unit, without recalibration. In other words, the multiprobes are interchangeable.

3.2 Changing the Scout 2 Display Unit Internal Batteries

The display unit internal battery pack consists of a plastic holder containing 10 "AA" size batteries. You should generally use alkaline type batteries to provide the longest service life. When the low battery indicator becomes activated (when the multiprobe battery reading drops below 10.0 volts), you should begin making plans to change the internal batteries (or recharge your external battery). The internal battery pack (when using alkaline cells) will operate your display unit and multiprobe with an attached stirrer continuously for at least 11.5 hours.

To change the internal batteries, begin first by disconnecting the underwater cable from the display unit and remove the display unit case from the bottom of the rubber boot. Use a flat-blade screwdriver to loosen the four screws on the top of the case. Loosen each screw a few turns then proceed to another screw to avoid undue stress on the case top. When all four screws are loose, carefully lift the top straight up and note the wiring harness that is connected. The wiring harness attaches to a printed circuit board (that is attached directly to the case top) using a latching connector. Push both retaining ears of the connector upwards to eject the wiring harness and free the case top.

The plastic battery holder is mounted in the bottom of the display unit case (under the rubber insulating material) using Velcro™ material. Remove the expired batteries and install 10 fresh "AA" alkaline batteries being very

sure to note the polarity markings on the battery holder. Be certain that all batteries are securely seated in the holder and place the rubber insulating material on top of the battery holder.

Reconnect the wiring harness to the printed circuit board by firmly pressing the connector in until the latching ears engage. Carefully position the case top over the case bottom and first making sure that the wiring harness will not be damaged, begin to tighten the four screws in the case top. Tighten each screw a few turns and then proceed to the next screw until all are tight.

Replace the rubber boot by inserting the display unit case from the bottom and working the rubber boot around the case. Connect the multiprobe and verify proper operation. The battery reading from the multiprobe should now be about 15 volts.

When using an external power source for an extended length of time, you should always remove the internal batteries so that they will not be discharged. An error message will appear if you attempt to use an external power source when you have internal batteries installed. See Section 6.2.



PART FOUR: DEPLOYMENT

4.1 Deployment in Open Waters

Protect the display unit from mechanical shock and excessive vibration.

4.2 Using the Stirrer

The same power utilized by the Scout 2 Display Unit powers the multiprobe, as well as the stirrer; so you might wish to have a spare battery handy if you are on a long field trip with extended stirrer use. If your measurements do not require the stirrer, be sure to disconnect it from the cable to extend the battery life. Don't forget to insert the dummy plugs into the two open connectors to prevent water damage.

4.3 Pressure and Temperature Extremes

The Scout 2 Display case is water-tight, but not rated for submersion. The display unit has an operating temperature range of -5°C to 50°C (about 23°F to 122°F). Exposure of the display unit to temperatures outside of this range might result in mechanical damage or faulty electronic performance. The latter may be very subtle.

4.4 Performance Measurement and Improvement

This manual is designed to best meet the needs of the "typical" field practitioner. However, if you have an application that demands increased performance or operation under unusual circumstances, Hydrolab Corp. is willing and able to help. Just call 800-949-3766 or 512-255-8841. Hydrolab's staff of engineers and application experts will be more than happy to share with you their years of experience in helping operators get good data under demanding field conditions. Just call.



PART FIVE: TECHNICAL NOTES

5.1 Dissolved Oxygen Temperature and Salinity Corrections

There are five components to the dissolved oxygen concentration (i.e., mg/l) reading: the "raw" sensor reading, a scale factor, the membrane temperature correction, the solubility temperature correction, and the salinity compensation. The raw reading is a function of the DO cell itself, and is related to the sensed partial pressure, not concentration, of oxygen dissolved in the sample. The scale factor is set by the operator during calibration. The membrane temperature correction is determined experimentally for each type of membrane. The solubility temperature function corrects for effect of temperature on the solubility of oxygen in water. The salinity function corrects for the effect of salinity on the solubility of oxygen in water.

The function used for membrane temperature correction at a temperature T (°C) for the Standard Membrane (1-mil Teflon) is:

$$F(T) = 2.2513 (10^{-7}) T^4 - 3.3116 (10^{-5}) T^3 + 2.2366 (10^{-3}) T^2 - 9.3778 (10^{-2}) T + 2.3761$$

The function used for membrane temperature correction at a temperature T (°C) for the Hydrolab LoFlow Membrane is:

$$F(T) = 7.6233 (10^{-7}) T^4 - 1.2322 (10^{-4}) T^3 + 8.2111 (10^{-3}) T^2 - 2.8240 (10^{-1}) T + 4.5557$$

In both cases, the raw DO signal is multiplied by $F(T)$ to produce the temperature-corrected reading, so divide the DO reading by $F(T)$ to un-correct for temperature.

The function used to convert DO % Sat to salinity-uncompensated DO mg/L is:

$$FC(T) = 100 / (7.2541 (10^{-9}) T^5 - 5.1387 (10^{-7}) T^4 + 9.8316 (10^{-5}) T^3 + 5.2276 (10^{-4}) T^2 + 0.19665 T + 6.8356)$$

The DO % Sat reading is divided by $FC(T)$, so multiply the DO mg/L reading by $FC(T)$ to un-compensate. The data used to generate this polynomial comes from the oxygen solubility data in the 1985 Standard Methods.

The function used to salinity-compensate DO (to "true" DO) for a specific conductance C (mS/cm) at a temperature T (°C) is:

$$F(C) = 1 - C(3.439 (10^{-3}) + 0.361 / (22.1 + T)^2)$$

range. If you need a more specific correction, then record your data as uncompensated conductivity (Section 2.6.2). Later, you can apply your own temperature correction to the data (for instance, in a spreadsheet).

Because resistivity is calculated from the temperature-corrected conductivity (i.e., specific conductance) reading, resistivity also has the above correction, as do salinity and total dissolved solids (TDS).

5.4.2 Specific Conductance to Salinity Conversion

The function used to convert specific conductance, C , to salinity, S , is:

$$S = 5.9950 (10^{-8}) C^4 - 2.3120 (10^{-5}) C^3 + 3.4346 (10^{-3}) C^2 + 5.3532 (10^{-1}) C - 1.5494 (10^{-2})$$

This relationship is taken from the USGS Water Supply Paper 2311. Note that while any specific conductance can be converted to salinity, salinity is defined only for mild dilutions and concentrations of seawater (say, the 30 to 40 ppt salinity range).

Note that salinity, unlike specific conductance, the parameter from which salinity is calculated, is not actually "temperature compensated". A part-per-thousand is a part-per-thousand, no matter what the temperature. However, the above conversion algorithm only works for conductivity readings that have been corrected to 25°C (i.e., specific conductance readings).

If you have more specific information on your particular samples, then record conductivity instead of salinity and, with a spreadsheet, calculate salinity from those readings.

5.4.3 Specific Conductance to Resistivity Conversion

Resistivity is simply the inverse of specific conductance. For example, the resistivity corresponding to 100 microSiemens/cm (0.1 milliSiemens/cm) is 10.0 K ohm cm.

5.4.4 Specific Conductance to Total Dissolved Solids (TDS) Conversion

TDS is calculated from specific conductance as:

$$\text{TDS} = C(0.640)$$

where TDS is total dissolved solids in K mg/l (i.e, g/l) and C is specific conductance in mS/cm (from Water Chemistry, by Snoeyink and Jenkins).

If you have more specific information on your particular samples, then record specific conductance instead of TDS and, with a spreadsheet, calculate TDS from the specific conductance readings.

5.4.5 Correcting Depth for Specific Conductance

The density of water, and hence its ability to "create" pressure, increases with specific conductance. Therefore, if a depth transducer is calibrated for fresh water, the depth reading must be reduced for measurements made in salt waters. The following correction is used for depth (and level) readings:

$$F(C) = 1 - 0.03(C/52)$$

C is the measured specific conductance in mS/cm. The raw depth readings are multiplied by F(C) to produce the displayed reading. In effect, no correction is made at zero specific conductance, and readings are reduced by three percent at 52 mS/cm, the specific conductance of sea water.

5.4.6 Measuring pH in Very Low Specific Conductance Waters

If you make pH or conductivity measurements in water whose conductivity is less than 0.2 milliSiemens/cm, please contact Hydrolab. Making measurements in very dilute solutions is a whole different ballgame, especially for pH. See the "Application Note on pH Measurements" located at the back of your multiprobe Operating Manual.

5.5 Turbidity

5.5.1 Measurement Principle

The ISO-7027 specification calls for a nephelometric detector at 90 degrees from an infrared light source of 860 nm. Hydrolab's turbidity sensor, when operated in nephelometric mode, meets all these specifications except the light source is at 880 nm.

The ratio mode adds a transmissive correction to eliminate the "blinding out" phenomenon common in nephelometric instrumentation at high turbidities.

Selection of mode is highly dependent upon your data requirements, adherence to any measurement specifications, and your primary range of measurement.

5.5.2 Ambient Light

The multiprobe measures the sensor responses when the light source is on and when it is off. The difference between the on and off responses is used to eliminate the effects of ambient light and provide the turbidity measurements.

But there is a limit to the amount of ambient light which can be rejected. If the ambient light "saturates" the sensors, then the on and off responses to the light source will be nearly the same. Incorrect turbidity values are produced. The multiprobe can detect when the ambient light is causing questionable turbidity data. When this condition is detected, a "?" is printed next to the turbidity data value.

The maximum ambient light threshold is equivalent to the amount of light reaching the sensor at a 1m submersion in "turbidity-free" water at full sunlight. At 1m deep, infrared light detected by the sensor is attenuated to 1%.

5.5.3 Light Source Variation

The light source output varies tremendously from part to part and over temperature. A third sensor was added to measure the light output and normalize the nephelometric and transmissive sensor responses.

Additionally, this third sensor allows the multiprobe to detect a faulty light source. The photodiode measures the light source output to insure proper operation. If the light source output becomes too low, a "?" is printed next to the turbidity data. To determine if the "?" is caused by ambient light or a faulty light source, shield the sensor from ambient light. If the "?" disappears, then the ambient light is too high. Otherwise, please contact Hydrolab Customer Service.

5.6 Performance Measurement and Improvement

This manual is designed to best meet the needs of the "typical" field practitioner. However, if you have an application that demands increased performance or operation under unusual circumstances, Hydrolab Corp. is willing and able to help. Just call 800-949-3766 or 512-255-8841. Hydrolab's staff of engineers and application experts will be more than happy to share with you their years of experience in helping operators get good data under demanding field conditions. Just call.

2011



PART SIX: TROUBLESHOOTING

NOTE: For troubleshooting the operation of the multiprobe, see your multiprobe's operating manual.

6.1 General

1) Display Unit display is blank:

- a) Are all connectors mated properly?
- b) If you are using an external battery, is the voltage between 8.5 and 13 volts?
- c) If you are using the Scout 2 internal batteries, is the voltage between 10.0 and 16.0 volts?
- d) Did you press the On/Off switch? Try it again.

2) Parameter reading(s) are missing or incorrect:

- a) Is your multiprobe equipped with the sensor for that parameter?
(**** means that the multiprobe does not have that specific sensor.)
- b) Are you looking at the correct screen (Main or Alternate) for the parameter sought?
- c) Check the Variables menu to make sure all variables are set as expected.

3) A calibration is not accepted:

- a) Are you sure of the value of your calibration standard?
- b) Are the sensors properly serviced? See Part Three of your multiprobe's operating manual.
- c) Did you enter the value of your calibration standard correctly, and in the proper units?

4) Dissolved Oxygen readings are too low to calibrate, and/or pH and/or redox readings are very high or very low:

- a) Are you sure of the value of your sample solution?
- b) If you are using the multiprobe's internal batteries, are they fresh? See Section 3.11 of your multiprobe's operating manual.
- c) Are the sensors properly maintained? See Part Three of your multiprobe's operating manual.
- d) Check the Variables menu to make sure that the type of membrane material specified is correct (Standard or LoFlow).

5) Specific conductance, temperature, and/or depth readings seem wrong:

- a) Are the sensors maintained and calibrated properly? See Part Three of your multiprobe's operating manual.
- b) Are you sure of the units being printed? For instance, are the depth readings in feet or meters? See Section 2.5 of this manual.

6.2 Scout 2 Display Unit Error Messages

Your Scout 2 Display Unit contains a set of self-diagnostics that can help you identify a problem. Some of the errors are fatal (i.e., the message will appear for about 3 seconds and the display unit will turn itself off). If you get one of these messages, try to turn the display unit back on again (press the On/Off key) to be sure that the error is consistent. The remainder of the error messages will appear for about three seconds before the previous data display screen is resumed. These can be caused by operator error.

Be sure to note the occurrence of any of these error messages when contacting the Hydrolab Service Department.

"Keyboard Error" During power up (when the On/Off key is pressed) the keyboard is checked for stuck keys. If one or more keyboard keys are pressed or stuck in a pressed position then this message will appear and the display unit will shut off after about 3 seconds.

"Ext Power is Applied, Remove Int Batteries" When the On/Off key is pressed, internal or external Scout 2 System battery operation is verified. If external power is connected with the internal batteries installed then this message will appear for 3 seconds before the display unit begins displaying data (see Section 3.12).

"Sonde not Responding" If the Sonde (multiprobe) is not functioning or not connected when the On/Off key is pressed, then this message will appear and the unit will shut off after about 3 seconds. Usually this error is caused by open cable wiring or insufficient battery voltage.

"Sonde Hardware Error" This message is shown if the multiprobe reports a hardware error. This message will remain until the error condition clears or the display unit is turned off.

"Sonde Response Error" This message is displayed if an unexpected multiprobe response occurred during the power up sequence. This might be caused by an intermittent cable failure or insufficient battery voltage. This message will appear for about 3 seconds and the display unit will then shut off.

"Unable to Enter Menu" The display unit is unable to access any of the multiprobe menu tree structure. This would be a rare error but might be caused by an intermittent failure that interrupted data synchronization between the display unit and the multiprobe. This message will appear for about 3 seconds and the display unit will then shut off.

"Sonde not Supported" The current Scout 2 software cannot display data from this instrument due to incompatibilities. This message will appear for about 3 seconds and the display unit will then shut off. This message is included for future Hydrolab instrumentation.

"CAL out of Range" An invalid calibration value has been entered and ignored by the multiprobe. The previous data display screen will resume after about 3 seconds.

"PARAM not available" An attempt to calibrate a multiprobe parameter that does not have a data probe installed. The previous data display screen will resume after about 3 seconds.



PART SEVEN

LOGGING

The DataSonde 3

Hydrolab offers the DataSonde 3 Multiprobe Logger for data logging applications that require a submersible logger. The DataSonde 3 is essentially identical to an H20, except it has a logger and battery supply built into the multiprobe housing. Programming and data recovery are done with a personal computer; logged data can be transferred directly to a personal computer, and then into spreadsheets, data bases, word processors, graphics packages, etc. Please call Hydrolab for specific information.

Logging with a Personal Computer

Almost any personal computer can communicate with, and accept data from Hydrolab multiprobes' standard RS-232 output. With software packages available from third-party software producers, this data can then be logged onto floppy or hard disc for later use. The software can be customized to your needs.

There are also several third-party field loggers available that interface to Hydrolab multiprobes via RS-232. Please call Hydrolab for specific information.

Logging with Analog Voltage Output

Hydrolab offers an Analog Converter that converts the Hydrolab multiprobe digital output to parallel voltages or currents. This allows a Hydrolab multiprobe to be used with virtually any logger, controller, or SCADA system that accepts analog inputs, while retaining the advantages of RS-232 for long cable runs. Please call Hydrolab for specific information.



APPENDIX 1

Technical Data

Scout® 2 Display Battery Current Consumption

(@ 12VDC input)

standby (Display Unit off) 26 μ A, 85 μ A max

active with H2O® Multiprobe 80mA, 125mA max
(Display Unit on)

active with H2O Multiprobe 120mA, 145mA max
(and Stirrer)

**ADDITIONAL
INFORMATION**

Date Shipped to Hydrolab _____

Serial No.

[illegible]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



R.G.A. No. _____

Date Shipped to Hydrolab _____

SERVICE MEMORANDUM

The following information is requested in order to process your order for warranty or non-warranty service. Please include this form, fully completed, with your return shipment.

Customer Contact Name _____

Customer Phone Number _____

Address for return
shipment of
repaired equipment

City

State

Zip

Address for billing
(or purchase authority)
for repair charges
not covered by warranty

City

State

Zip

WARRANTY INFORMATION – please check the appropriate box and furnish requested materials:

- ☐ Sales Warranty Attach copy of Invoice or Proof-of-Purchase
- ☐ Service Warranty Attach copy of previous R.G.A.
- ☐ Non-Warranty Method of payment: ☐ VISA/MC ☐ P.O. No. _____
- ☐ Other _____

SHIPPING INSTRUCTIONS – Please refer to the instructions given under SERVICE AND WARRANTY (found in the back of your Instrument Operating Manual) before packaging your instrument for shipment to Hydrolab.

Note: Please install dummy plugs and fill storage cups about 2/3 full of water prior to packaging.

Address each carton to:

HYDROLAB CORPORATION
SERVICE DEPARTMENT
12921 BURNET ROAD
AUSTIN, TX 78727 U.S.A.

Please clearly mark each box with: R.G.A. No. _____
Carton # _____ of _____

Please describe equipment problem on the reverse side of this memorandum.

Serial No.

[illegible]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Date Shipped to Hydrolab _____



SERVICE MEMORANDUM

The following information is requested in order to process your order for warranty or non-warranty service. Please include this form, fully completed, with your return shipment.

Customer Contact Name _____

Customer Phone Number _____

Address for return
shipment of
repaired equipment

City

State

Zip

Address for billing _____
(or purchase authority) _____
for repair charges _____
not covered by warranty _____

City

State

Zip

WARRANTY INFORMATION – please check the appropriate box and furnish requested materials:

- ☐ Sales Warranty Attach copy of Invoice or Proof-of-Purchase
- ☐ Service Warranty Attach copy of previous R.G.A.
- ☐ Non-Warranty Method of payment:
- ☐ VISA/MC ☐ P.O. No. _____
- ☐ Other _____

SHIPPING INSTRUCTIONS – Please refer to the instructions given under SERVICE AND WARRANTY (found in the back of your instrument Operating Manual) before packaging your instrument for shipment to Hydrolab.

Note: Please install dummy plugs and fill storage cups about 2/3 full of water prior to packaging.

Address each carton to:

**HYDROLAB CORPORATION
SERVICE DEPARTMENT
12921 BURNET ROAD
AUSTIN, TX 78727 U.S.A.**

Please clearly mark each box with: R.G.A. No. _____
Carton # _____ of _____

Please describe equipment problem on the reverse side of this memorandum.

Serial No.

[illegible]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.